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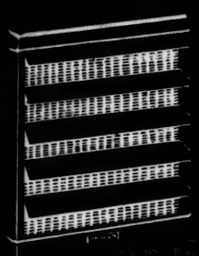

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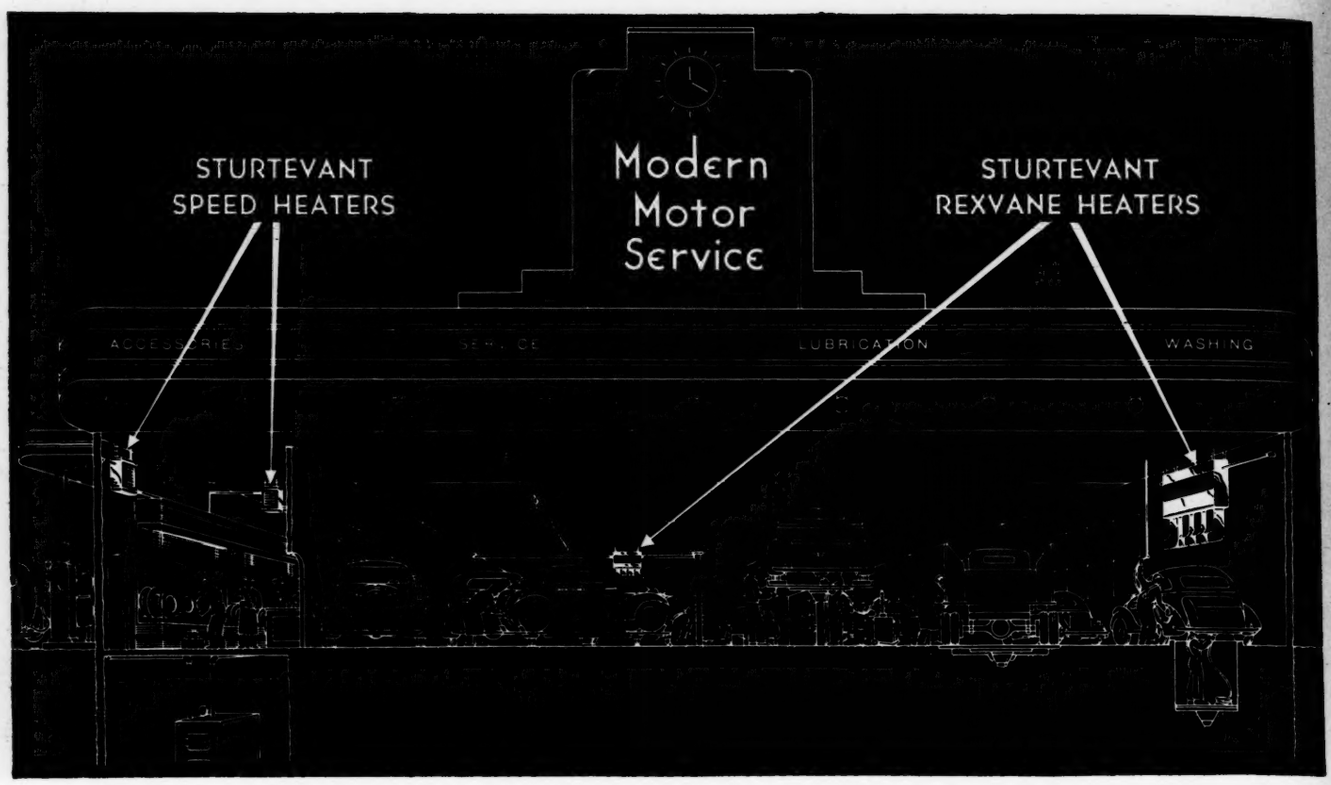

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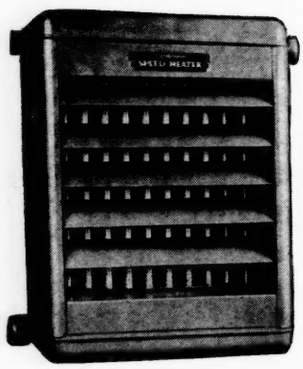

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What Air Conditioning Engineers Should Know About

Photo courtesy Photo. Div., WPA Federal Art Project

In this, the first of three articles on this subject, the author describes the various types of micro-organisms found in the air, how they are grown, and how they are counted.

IF the activity of research laboratories is a reliable index, air sanitation will not be long in taking a place alongside the presently accepted arts of heating, ventilating, air conditioning and industrial hygiene.

The present principal concern of the sanitary engineer, chemist and bacteriologist is that the public be protected from disease from water, food, and the diseased persons or objects with which it comes in direct contact. Their concern that epidemic disease may be communicated through the air we breathe is not great. It therefore does not become non-medical members of the heating, ventilation and air conditioning professions to turn alarmists and scare the public into believing that they are living in a dangerous atmosphere laden with disease-producing micro-organisms. Nevertheless, when reliable surgeons report that wounds from operations performed in rooms in which the air as well as the instruments and clothing were sterilized heal with less complications than those from operations performed in non-sterile air, and when evidence accumulates showing the presence in the air of occupied rooms of micro-organisms of the identical type of those found in the noses and throats of the occupants, including those suffering from naso-pharyngeal diseases, we may begin to doubt the wisdom of ignoring the air as a means for transmitting disease and infections. It now behooves us to acquire a basic knowledge of these micro-organisms, and the methods of measuring and controlling them in the air of ventilating systems.

What Micro-Organisms Are

As their name implies, micro-organisms are living organisms too small to be seen with the naked eye. From Leeuwenhoek, who first saw them in 1680, to Pasteur, a period of 175 years, the micro-organisms of water and food were studied exhaustively, and it was shown that the group could be subdivided into a

†Consulting Engineer, New York.

number of categories such as protozoa, moulds, yeasts and bacteria. Whether these organisms belong to the vegetable or animal kingdom is a question that has agitated scientists for years. Their classification within one or the other kingdom is purely academic because they possess characteristics of both. *Protozoa* are usually considered the most minute species of the animal kingdom; *moulds* and *yeasts* are thought of as the smallest members of the fungus family and are thus the tiniest of the vegetable kingdom; *bacteria,* which are of smaller size than either protozoa, moulds or yeast, possess characteristics closely akin to both so that they may be considered both animal and vegetable at the same time and therefore are the most minute members of both families. A *virus* is an organism too small to be seen through a microscope; recent researches indicate that it is not much more than a complex chemical miraculously endowed with the ability to reproduce itself.

Almost all of these minute forms of life produce spores, which are a passive reproductive state of the organism from which later a new one may grow. In the case of bacteria, each bacterium converts itself into a spore; whereas each mould and yeast plant produces numerous spores by budding in the manner that a flower produces pollen. Although pollen must be deposited on a flower before a reproductive seed can grow, the spores of mould, yeast or bacteria can grow into a new organism directly if only they be in the proper environment.

By restricting our consideration to only the microbiology of the air, protozoa may be dismissed because they are too heavy to float in air and even if they could, have practically no hygienic significance. Moulds and yeasts, as such, are also not normally to be found floating in air, although their spores are largely transported from place to place by air. Our principal interest centers on the bacteria. It is noteworthy, however, that the methods to be described for studying bacteria also apply in general to the study of moulds and yeasts, except that different culture media, incubation temperatures, etc., must be employed. No further attempt will be made here to discuss viruses.

Kinds of Bacteria

Bacteria are saprophytes or parasites, although some exhibit both characteristics. The latter require the living substance of plant or animal hosts in order that they may grow and reproduce; the former can survive on dead or inorganic foods. Bacteria are called pathogenic if they are factors in the production of disease in man or animals. In air sanitation we are principally interested in the pathogens. However, there are a number of industrial processes dependent for their success upon the presence or absence of certain non-pathogenic micro-organisms. The organisms of fermentation and decay are not wanted in most food establishments, yet certain members of the group are vital for the fermentation of wine and beer, the tanning of leathers, the making of bread, the production of sour cream and cheese, the manufacture of vinegar, and even for the commercial production of certain basic organic chemicals. The practice of hanging meat to allow whiskers of mould to form is well known. It must be carefully controlled lest the decaying action of bacteria proceed faster than the tenderizing and flavor-giving action of the mould.

In addition to a general classification as saprophytic or parasitic, pathogenic or non-pathogenic, bacteria are also grouped according to both their morphology and to their reaction to certain biochemical tests. By morphology is meant their appearance under the microscope, although, when a large number of micro-organisms grow together in a clump or colony, it is also possible to describe the morphology, or physical appearance, without magnification or under low magnification, of the colony. These colonies differ in size, color and shape depending both on the organism and the media on which it is being cultured. (To culture a micro-organism is to keep it alive and uncontaminated with other micro-organisms.) The substances on or in which this growth takes place are called the media. It is, of course, also possible to grow a contaminated strain or a mixture of organisms on the same media, but in bacteriological laboratory procedure, this is done only until a pure (uncontaminated) culture can be obtained. In preparing a pure culture from an impure one, all materials used, except original culture, must be sterile, otherwise organisms already present in the material would appear in the culture. Sterile material is material without any living micro-organisms or spores and is obtained by prolonged heating in a sterilizer. Material must be kept in the sterilizer long enough and at a high enough temperature to kill even the most resistant spore that might be on the material. Because spores are more resistant to destruction than the organisms which formed them, any process which kills the spores will kill the organism producing the spore much earlier in process of sterilization. Sterilization is usually performed in autoclaves where steam under pressure (about 15 lb. gage) is kept in contact with the material for from ten to twenty minutes. Glassware, such as flasks, bottles and tubes, is usually closed before sterilization with plugs of densely wadded cotton which prove to be an effective barrier to the infiltration of bacteria from the outside air. Once the inside of a properly stoppered bottle or tube is sterile, the sterility or non-sterility of the outside is of little import. Media must also be sterilized and kept in stoppered sterile bottles. The platinum wires by which organisms are transplanted from one media receptacle to another are sterilized by holding in the flame of a bunsen burner until red hot. Sand or any metal objects which may be used in contact with organisms being cultured may also be sterilized by heating in a furnace or over a flame instead of in a sterilizer. In general, most bacteria are killed by exposure for about ten minutes at between 130 and 140 F. The higher the temperature the less time is required to kill the organism. Spores, however, are more resistant and require temperatures above boiling to insure sterilization. Most textbooks and laboratory manuals state that all spores may be killed by fifteen minutes exposure to a moist heat of 125C (257F).

Growing Bacteria Cultures

The media upon or in which cultures are grown must have certain properties, particularly that of supplying

food energy to the organisms. It must have both the proper choice of food elements and the proper pH so that the environment will have the acidity or alkalinity necessary for the organisms' most prolific growth. The components of media are chosen so as to provide an environment in which most rapid growth will take place in the minimum time of incubation. The commonly-used medium is a beef infusion, extract or broth to which is added peptone, salt and either acid or alkali to adjust the final pH to that desired. This forms a liquid in which bacteria can grow. By mixing beef broth with agar-agar (a gelatinous substance made from sea-weed), a substance results which is solid at room temperature but is liquid enough to pour when slightly heated. When beef broth agar is poured on petri dishes or plates and allowed to harden, bacteria can then be grown on the surface of the media (rather than in the media, as in the case of broth). A petri plate is a cylindrical dish about six inches in diameter with cylinder walls about one inch high, which has a cover, an inverted cylinder of slightly larger diameter and slightly shorter wall height. When the word plate is used alone in bacteriological parlance, the reference is to a petri dish.

There are hundreds of different formulas for special media depending for their difference upon the addition of one or more chemicals (particularly inorganic salts and sugars such as lactose or sorbose), to the basic beef broth-agar combination. Each of these special media is designed to grow a particular organism at maximum efficiency. One particular class of special media frequently used in air bacteriology is that in which about 5% of sterile blood (rabbit, sheep, horse or human) is added to a beef broth agar.

In addition to the standard media noted, cultures are also sometimes grown in milk, gelatin, or on slices of potato. In order to grow organisms for laboratory identification, not only must one start with proper sterile media in sterile glassware, but means must also be available for controlling the temperature of growth. A sterile plate (containing beef broth agar) is inoculated with the bacteria to be cultured and is placed in the incubator, which is nothing more than an insulated constant temperature oven, designed to be held at 37C (98.6F), 20C (68F), or some other definite temperature. Incubation times are generally multiples of 24 hours. Inoculation consists of touching the tip of a sterile platinum wire to the colony of micro-organisms on one plate which it is desired to perpetuate on another, and then scratching this wire across the surface of a sterile plate. Thus if the original plate or tube contained 100 different colonies of various kinds and types it would be possible to "fish" from any one of the colonies and from the material thus transplanted to a new plate only two or three different types of colonies might grow. Then by repeating the operation once or twice more, a plate may be produced having no types except the one desired. This is now a pure culture and may be perpetuated by transfers from time to time to new plates of similar media or into tubes of broth. It should be obvious that, although it is possible to perpetuate a pure culture in broth, it is impossible to separate a mixture of cultures in broth, one from the other. Thus if the original sample of bacteria is obtained in a liquid medium, it must be "plated" on agar plates for identification and the preparations of pure cultures. "Plating" consists of pouring the liquid media in which is growing a mixture of organisms and liquid (heated) agar onto a plate simultaneously so that they may mix before the agar cools and hardens. If an inoculation wire be dipped into a liquid medium containing organisms and then be scratched across a sterile nutrient plate, a transfer of some of the organisms in the liquid medium to the plate will be effected, but there is the likelihood that many types of organisms present in the broth may not be transferred. After an incubation period of from 24 to 48 hours at 98.6F or 68F, most plates will show a growth if organisms are present whose life the media will support.

Examination Under Microscope

As previously noted the morphology of a colony may be observed with the naked eye. The morphological examination of an individual micro-organism involves a microscopic examination and the use of selective stains. The technique of this type of examination involves placing a drop of sterile water on a clean microscope slide; adding to this drop a small quantity of the organisms to be observed by means of a sterile platinum wire touched to the colony and then to the drop; evaporating the water; heating the slide to fix the film and later, if desired, affixing a clean cover slide. In general it is necessary to stain the slide with an alcohol solution of an analine dye such as gentian-violet or methylene-blue before studying it under the microscope. By a choice of stain and chemical treatment before and after staining, it is possible to selectively stain certain organisms a distinctive color while other organisms remain another color or colorless. There are as many different stain techniques as there are media, but the most common is Gram's stain of gentian-violet followed by an iodine-potassium iodide solution and a rinse in alcohol. This stains some organisms violet (Gram positive) and others remain colorless (Gram negative).

Under the microscope the organism is inspected for shape, size and its relation to other cells of the same group. Organisms appear as spheres (cocci), rods (bacilli), chains of spheres (streptococci), groups of spheres (staphylococci), masses of spheres (sarcina), or long spirals (spirilli). Intermediate curved forms are also observed. The microscopist notes the presence or absence of hair-like appendages called flagella, of evidence of spore formation, of capsules (a distinctive outer membrane), the shape of the ends (rounded, truncated, concave or square) and perhaps, more important, the size in microns (1/1000 mm.) of each individual bacterium. Most bacteria fall within the range of between 0.5 and 2.5 microns in length, width or diameter. The measurement of size is performed in the same manner that the size of a dust particle is measured, by means of a filar micrometer eyepiece on the microscope or a graduated screen inserted into the eyepiece. Both methods require calibration against an accurately ruled stage micrometer. In some instances instead of drying the film on the slide and thus killing the organ-

isms, bacteria are viewed in a droplet of liquid (hanging from the under side of the slide) for mobility (movement) and other characteristics while still alive.

The remaining tests to determine the type and species of an organism involve the growth of the organism in test tubes containing first, some basic foodstuff such as peptone or beef broth; second, a specific substance upon which the organism may act, such as any of the sugars, dextrose, lactose, sucrose, saccharose, sorbose, etc.; and third, a chemical indicator which will change color if a chemical reaction has taken place. For instance, when the indicator bromocresol-purple is used and no reaction takes place, the indicator remains purple; but if the sugar is fermented by the organism, with the consequent production of small quantities of fermentative gases, the indicator will change to yellow to indicate the presence of acid. The ability of the organism to live without oxygen, its ability to dissolve bile, liquefy gelatine, reduce methylene blue, produce hydrogen sulphide, ammonia or other substances when placed in specific media, are all used in additional biochemical tests to help identify an organism.

The procedures discussed represent only the more elementary ones. Although most common organisms can be identified by these simple methods, there are many more advanced techniques dependent on the action of the organisms with respect to blood and blood serum and its action when injected into or recovered from test animals, such as mice, guinea pigs, rabbits, sheep, birds, horses, monkeys, etc. Only one of these is sufficiently common to require description; that is, the phenomenon called hemolysis of blood, which is observed on blood agar plates during the growth of certain important organisms. Such a plate has the reddish color of blood. However, whenever a streptococcus possessing the ability to hemolyze blood grows on the plate, the red color disappears in the vicinity of the organism, leaving the plate colorless (Beta hemolytic streptococcus), or with a greenish coloration—Viridans (green-producing) —Alpha hemolytic streptococcus.

These various tests plus other cultural characteristics (odor, sediment, clouding, growth and appearance) when grown in broth or other liquid media, and grown in agar or gelatin (instead of on it) complete the laboratory methods of bacteriology.

The author's second article will appear next month.

What Name For Heat Value?

A FRIENDLY controversy now raging in the American Society for Testing Materials' Committee E-8 on Nomenclature and Definitions requires additional opinions on the subject before a solution can be reached, says "Industrial Standardization." Shall the term "calorific value" be used to indicate the heating value of a fuel, or shall some other term, such as "heat of combustion," be accepted as the standard?

A subcommittee has been assigned to the task of selecting the standard, and has found that a number of different terms are now in use:

***calorific value*, because a calorimeter is used in determining the heating value of a fuel**
***B.t.u. value*, because results have frequently been reported in terms of the British thermal unit**
thermal value
heating value

The subcommittee is inclined toward the term "calorfic value," because of its wide acceptance internationally as well as nationally. The British Standards Institution has adopted "calorific value." It is also similar to the French "pouvoir calorifique," and to the German "heizwert."

The opinion of the subcommittee is, however, divided, several members favoring the term "heat of combustion" as being more accurate. This point of view is expressed by one of the members of the subcommittee:

"While it is true that terminology may not be of prime importance and it is more important to be consistent than to be correct, I feel still that the subject of heat of combustion vs. calorific value is worthy of further thought. The mere fact that calorific value appears to have somewhat the advantage in present usage is not a particularly good reason why it should be adopted in preference to a wording which is possibly in almost as common use and which is distinctly superior for the purpose.

"While 'calorific value,' 'pouvoir calorfique,' and 'heizwert' are all parallel, they quite distinctly reflect the attitude of the mind before the thermal chemical problems were as well understood as they are at present. Undoubtedly the object of experiments on heats of combustion was to determine the 'calorific power' or heating effect of fuels. The thing which is actually measured is simply the 'heat of combustion.' Whatever other elements come into the problem are not subject to measurement. It seems therefore quite clear that we shall be on a much better logical basis in using a term which defines quite closely the thing which we actually measure; i.e, the heat of combustion as such.

"Considering all the phases of the problem, it seems to me that the only valid argument for the use of calorific value is its apparent greater popularity at the present time. Over against that, the term heat of combution is not only more logical and represents more accurately the thing which is measured, but is also a simpler term to use and more readily understood by all those who may be concerned with it."

Shall the term "calorific value" be standardized? Or shall one of the terms "thermal value," "heat of combustion or heat value," or, as has been suggested, "calorific value (heat of combustion)" be used?

Any one having a definite opinion on this question is asked to write to H. C. Porter, chairman, Subcommittee on Definitions of Net and Gross Calorific Values of Fuels, care of the American Society for Testing Materials, 260 South Broad St., Philadelphia.

Throngs, sometimes numbering 70,000 daily, attend services at Our Lady of Sorrows Church, Chicago, during the perpetual Novena conducted there. The phenomenal increase in attendance not only fills the shrine built for the Novena but also the upper church and adjoining parish hall.

Chicago Church Conditioned by 105-Ton Plant

By KNIGHT C. PORTER†

THE air conditioning industry has for many years viewed the churches as an interesting market. Rarely, however, did a church inquiry get beyond a preliminary estimate. Fixed costs in relation to hours of usefulness were usually too high. At the turn of the year, there were only two artificially cooled churches in Chicago; probably not exceeding a dozen in the country.

In January, 1938, it became apparent that Chicago was to have a third air conditioned church. A special benefit party was given by Our Lady of Sorrows Roman Catholic Church for the purpose of raising funds for an air conditioning system for the main shrine of the church. The proceeds were reported as $11,000 net.

Unlike the two previous installations, which were made at the time of building the churches, Our Lady of Sorrows had managed without air conditioning for fifty years. Therefore, the story of Our Lady of Sorrows and the Perpetual Novena must be told.

Less than two years ago, the lower portion of the familiar west side landmark was remodeled as a shrine for a perpetual Novena. A Novena is a devotion performed by saying a series of prayers for a special favor or thanksgiving on nine successive days. The first Novena was held on Friday, January 8, 1937, by the Reverend James R. Keane, O.S.M. On the following Friday, 2500 Novenites attended the service, so that two services were necessary as the seating capacity of the shrine is only 1000. Since the first of the year, Our Lady of Sorrows has been receiving the prayers of from 50,000 to 70,000 persons every Friday. In order to accommodate the crowds, thirty-five to thirty-eight 45-minute services have become the rule. Services are held from 6 a.m. through 10 p.m. With the main shrine filled, it became necessary to open the upper portion of the church and the Parish Hall in an adjoining building. The Parish Hall also has a seating capacity of 1000 people.

It is apparent, then, that the religious enthusiasm which has been achieved by the Very Reverend James R. Keane, Prior, and his assistant priests of the Servite Order has had more to do with the air conditioning of Our Lady of Sorrows Church than any other factor. The Perpetual Novena has given the church a high occupancy for long hours.

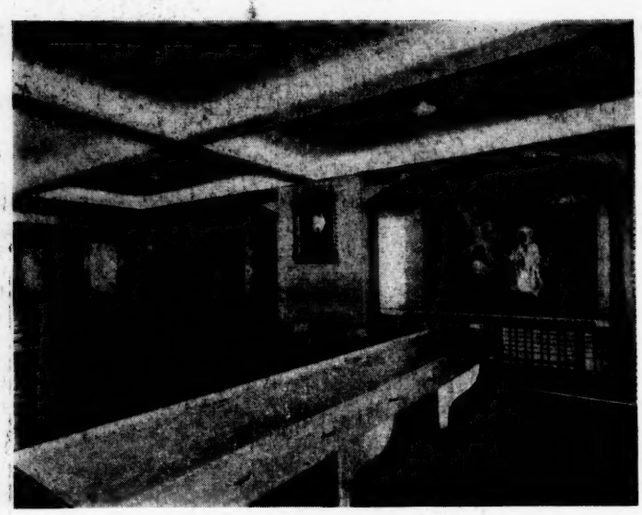
The original Novena party in January was held to raise funds for the shrine air conditioning. Later the project was extended to include the Novena office, a small chapel, and the Parish Hall. The Kroeschell Engineering Co., Chicago, engineered and installed all of the four separate systems. The systems, in order of their installations, are:

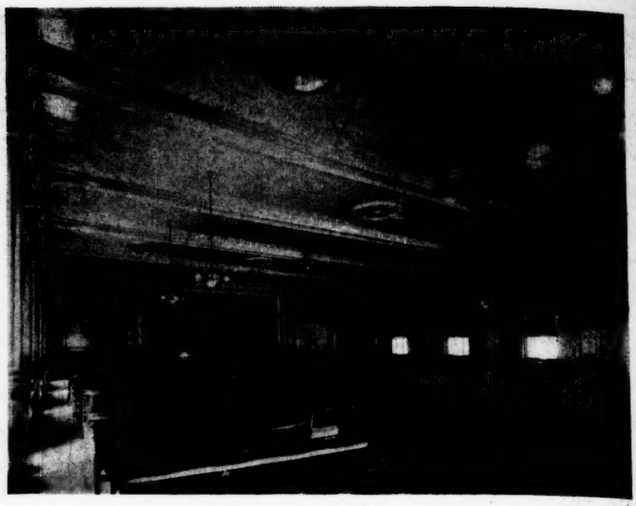
Space	Location	People	Tons Refrig.	Functions
Main Shrine	Church Basement	1000	50	Cooling and Heating
Novena Office	Church Basement	6	1.5	Cooling and Heating
Servite Fathers Chapel	Main Floor	30	3.75	Cooling
Parish Hall	Rear Building	1000	50	Cooling

Main Shrine

Probably the most interesting application of all is that of the main shrine. The basement space is 50 ft. wide and has only a 9-ft. ceiling. Adding to

†Air Conditioning Division, Commonwealth Edison Co., Chicago.



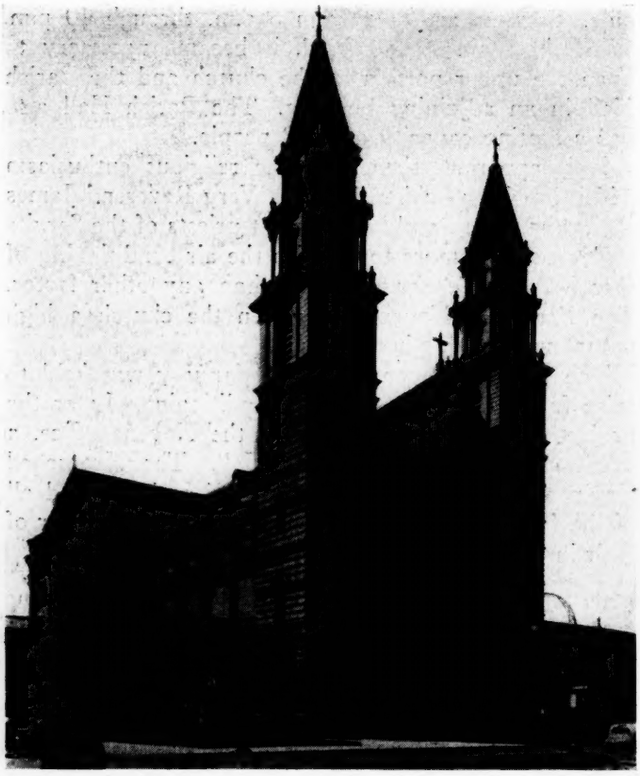


(Left) The architectural treatment of Our Lady of Sorrows shrine is enhanced by the comfortable condition provided by air conditioning. The directional flow grilles for uniformly distributing conditioned air in the church are located on the sidewalls directly above the individual shrines. (Right) The interior of the auditorium of Our Lady of Sorrows parish hall has year-round air conditioning. Anemostats are located in the ceiling for uniformly distributing conditioned air.

the air distribution problem are rather heavy ceiling beams. The fifty-year-old church has 5-ft. thick masonry walls in the basement—typical of European practice. Some application aid was offered by the original warm air heating ducts in the side walls. However, the original ducts and grilles had to be altered and supplemented considerably in order to accomplish uniform and draft-free air distribution. Seventy-five hundred cubic feet of air per minute is now supplied from each of the side walls by a separate 5-hp. blower. Each fan system is supplied with cooling from a 25-hp. compressor. Compressors are equipped with unloaders for 50% capacity reduction. In addition, there are two 4400 c.f.m. exhaust systems of 1 hp. each. The exhaust systems are interconnected with the supply fans. Return air is taken through inconspicuous grilles at the top of the wall shrines. Steam for heating and humidification is provided from a central boiler plant. No radiators are required with this system.

Novena Offices

An office staff of six persons is maintained to handle the correlation and dissemination of Novena publicity. This office is in the basement adjacent to the shrine.



(Left) Our Lady of Sorrows Church, Chicago, for fifty years serving faithful Catholics, was recently modernized by a complete Westinghouse year-round air conditioning system for the comfort and health of its parishioners and visitors. (Right) The chapel of the Servite Fathers is conditioned by a self-contained unit, and the air is circulated through the directional flow grilles located above the altar.

Since its hours of occupancy are somewhat different from those of the shrine, the office has its own independent system for cooling and heating. A 1.6-hp. compressor, located in the fan room, supplies cooling to a suspended fan unit located in the office. Outside air is admitted to this small fan system by an automatically operated damper. The ½-hp. fan delivers 1000 c.f.m. to the office.

Servite Fathers Chapel

The Servite Fathers Chapel, having its own special hours of use as well as being somewhat remote from the shrine, also has an independent system. This system is for cooling only—the existing heating system being satisfactory.

Here the load was such that the standard 3¾-hp. self-contained unit air conditioner was applied. The unit is located in the basement below the chapel and is connected to a complete system of supply, recirculation, and outdoor air ducts. Fifteen hundred c.f.m. of air is handled by a ¾-hp. fan motor. Because of the need for quiet conditions in this chapel, the supply ducts are acoustically treated.

Parish Hall

As previously mentioned, the popularity of the Novena caused overflow crowds to occupy the auditorium of the Parish Hall. The cooling capacity of this system is identical with that of the main shrine. Two 25-hp. compressors are located in the first floor machinery room. They supply refrigeration to two factory-built air conditioners located in the attic space above the ceiling of the auditorium. Each of the conditioners has a 5-hp. fan which handles 7900 c.f.m. Because of the availability of attic space overhead, introduction through ceiling inlets is employed for the main auditorium and through directional flow grilles for the balcony.

This is the story of the air conditioning systems of Our Lady of Sorrows Church. However, I doubt if any air conditioning man would fail to recognize that the big story of air conditioning in Our Lady of Sorrows Church is the now famous Perpetual Novena.

Schemes for Controlling Climate

LOOKING at the field of controlled climate, whether it includes proper washing, filtering and humidifying of air for an entire office building or simply cooling off under a cheap chain store fan, man's best efforts are picayune as compared to the grandiose schemes that have been suggested in the past. In short our forefathers' first conception of a "package unit" for controlled climate involved much larger packages.

Among the fantastic ideas which have been advanced in the past is that of constructing immense ducts running north and south and through which air could be forced and directed as necessary. Cold air from the arctic circle in July; equatorial breezes in December!

An equally large idea was advanced at the close of the Civil War, although not with the intention of offering any climatic benefits. According to the story, an army engineer with the Union forces, peeved at the way in which England had aided the South, proposed to Congress that a large dam be constructed from the tip of Florida to the West Indies, thereby bottling up the Gulf Stream. A glance at a map will readily convince anyone that the northern latitudes of the British Isles would provide them with an uncomfortably cold climate, and a short growing season, had the warm Gulf Stream not treated them so kindly.

Just what this change in the Gulf Stream might do to the English climate is still open to conjecture. Distance from the equator is not always an exact indication of the bottom mark reached by the thermometer. According to Vilhjalmur Stefansson in "Adventurers in Error" the school geographies have persisted in misinforming our youth in regard to climate and temperature. The simple idea that the further we travel from the equator, the colder the temperature becomes, is *too* simple, he says. He points out that he has perspired at 102F, well up within the Arctic Circle, and his explanation is especially interesting. The heat effective in a certain area depends not only on the heat source but upon the time of application as well. Consider a square mile somewhere in the Arctic and another one in Texas. The inclination of the earth to the sun's rays might be such that the rays are only half as effective near the pole. But in Texas the sun shines 12 hr. per day and in the Arctic summer, 24 hr. The net results are equal amounts of heat applied, and hence the 102F in the Arctic.

In addition to the question of temperature, the amount of rainfall has concerned man since he began to till the soil. The task of causing rain, which was first in the hands of tribal gods and witch doctors, was eagerly dropped into the lap of science in the nineteenth century. During that period every extensive drought was marked by the appearance of "scientists" who, by the properly impressive apparatus would, for a fee, cause anything from a slight shower to a cloudburst. One still sees an occasional account of a rainmaker offering his services, but the public is skeptical.

Doubtless millions of people today believe that heavy explosions will cause rain and they can point to the unusual precipitation in Europe during the War to prove their contention. A book appeared on this subject in 1871 ("War and the Weather," Edward Powers) and in 1891 the U. S. government authorized extensive bombing experiments in Texas under the direction of General R. G. Dyrenforth. The General had no use for his umbrella for, according to the official report, "these experiments have not afforded any scientific standing to the theory that rainstorms can be produced by concussions."

About 18 years ago a more scientific approach was made to the problem of producing rain. The method involved sprinkling charged sand particles over clouds with the idea that drops of moisture would collect due to their electric charges, and hence fall as rain. Extensive experiments were carried on, using planes equipped with the proper apparatus but the results were inconclusive. However, it did rain sand.—*T. C. Lloyd, Asst. Chief Engineer, Robbins & Myers, Inc.*

Check List for Heating Servicing

By ALFORD G. CANAR

House-Heating Div., The Peoples Gas Light and Coke Co., Chicago.

HOT WATER SYSTEMS

Complaint—Slow or Insufficient Heat Throughout the Building

Possible Cause	Check	Details	Remedy
Insufficient heat input to boiler	Time required to raise temperature of water	Average job—about 1½°F per min. Underrated job—1¾° to 2°F per min. Overrated job—1° to 1½°F per min.	Increase burner input.
Shortage of radiator surface	Amount of radiator surface	Determine heat loss of building and check against actual heat output of surface installed.	Increase burner input and set water temperature control higher. Install a closed system with tank for temperatures over 200F. Add surface.
Slow or sluggish circulation	Piping	Check pipe sizes against piping tables. Check pitch of mains and connections.	Increase burner input. Balance circulation with orifices. Install circulating pump.
	Air vents	Radiators may be airbound.	Open vents to allow air to escape.
	Water level	System may not have enough water.	Fill to proper level.
	Boiler insulation	Circulation is slowed up because high heat loss of boiler reduces water temperature.	Cover with good insulation.
	Piping insulation	Circulation is slowed up because high heat loss of piping reduces water temperature.	Insulate all mains and reduce infiltration to basement.
Radiator covers	Radiator covers	Covers may interfere with air circulation to radiators.	Change design or remove.
Undersized boilers	Boiler rating against total load	Boiler may be large enough for radiator load but because of shortage of radiator surface it is not large enough for building. Boiler may be overloaded.	Increase burner input or install larger burner. Install copper coils in firepot. Install larger boiler.
Oversized boiler	Boiler rating against total load	Greater volume of water will cause greater standby losses.	Increase burner input.
Loss of water from system	Water relief valve and expansion tank	Closed systems without expansion tanks during firing periods will lose hot water which will be replaced with cold water.	Install cushion tank.
	Water level and overflow line	Open systems if too full will overflow on firing periods. If no vent is used in overflow line, system may lose water by siphoning.	Fill to proper level. Install vent on overflow lines.

Complaint—Slow or Insufficient Heat in One or More Rooms

Possible Cause	Check	Details	Remedy
Insufficient radiator surface	Heat loss and radiator surface	Determine heat loss of room and check against actual output of surface installed.	Paint bronzed radiators. Set water temperature higher and reduce circulation to other radiators. Make more favorable tapping of riser on main and increase pitch. Install more surface.
Slow or sluggish circulation	Piping	Check piping size to radiator, also check pitch and main connection.	Set water temperature higher and reduce circulation to other radiators. Make more favorable tapping of riser on main. Increase pitch. Change pipe size.
	Radiator vents	Air in radiator may interfere with circulation and reduce surface.	Open vents to remove air.
	Water level	System may not be filled with water.	Add water.
	Radiator valve	Dirt in valve opening may reduce circulation. Faulty valve may not open properly.	Clean, repair, or replace valve.
	Radiator connections	Water may be bypassed due to improper connections. Inlet and return may be tapped off same main in two-pipe system.	Make more favorable connections to main and return.

Complaint—Noisy System

Possible Cause	Check	Details	Remedy
Water boiling	Water temperature	Boiling water will cause a noise like a water hammer. Temperature of boiling in open systems will depend upon height of system.	Provide water temperature limit control and set 215F or lower.
Expansion of piping	Size of pipe holes through floor	Expansion of pipe causes risers to be forced against sides of holes in floors causing a rubbing action.	Enlarge floor holes.

STEAM AND VAPOR SYSTEMS

Complaint—Slow Heating or Not Enough Heat Throughout Building

Possible Cause	Check	Details	Remedy
Insufficient heat input to boiler	Time required to raise 1 lb. of steam pressure or to kill vacuum	Atmospheric system with all radiators on—Average job—20 to 30 min. Underrated job—10 to 20 min. Overrated job—30 to 40 min. Vapor system with all radiators on—Average job—15 min. Underrated job—10 min. Overrated job—20 min.	Increase burner input to desired steaming rate.
Shortage of radiator surface	Amount of radiator surface	Determine heat loss of building, divide by 240 and check against actual surface installed.	Set pressure control to higher setting and minimum differential and increase burner input. Paint bronzed radiators. Add surface needed.
Slow or sluggish circulation	Piping	Check sizes of all pipes against piping tables for particular system. Check riser connections on mains, pitch of all pipes especially for trapped lines, for possible bypassing.	Correct pipe size, riser connections, pitch and eliminate bypassing if necessary.
	Valves	Make sure nipple and valve openings are not clogged. On one-pipe system see that valves are of type with openings equal to full pipe size. Also check other valves to see that they are of proper type.	Clean or replace nipples or valves. Replace improper valves.
	Air vents	Look for clogged air openings on vents. Make sure vents do not pass steam. Vents should be located as low as possible on radiators, on ends of mains and returns and on dry returns at top of vertical drop to boiler return. Main and return vents should be of return, quick venting type. On two-pipe vapor systems check operation of air eliminators and traps.	Clean vent openings. Replace corroded valves. Install in correct position if necessary. Clean or repair poorly operating eliminators or traps.
Uncovered or poorly insulated boiler	Boiler insulation	An uncovered or poorly insulated boiler will steam poorly because of increased standby loss and condensation in dome.	Cover with good insulating material.
Uncovered or poorly insulated piping	Pipe insulation and air infiltration to basement	Uncovered or poorly insulated piping will decrease amount of steam especially when basement temperature is low.	Insulate mains and reduce infiltration to basement.
High water line in boiler.	Position of water line	Water line should be in center of gage glass. High water line increases water volume and decreases steam volume and with burner input set for normal water line, input will not be sufficient and slow steaming will result.	Lower water line to normal position. If burner capacity is not sufficient for proper steaming, lower water line a few inches.
Water leaves boiler	Water level and return connections	With a fast steaming boiler, pressure may build up so rapidly that the pressure in boiler will back the water out through returns and low water cut-off will shut off burner before radiator gets hot.	Install a Hartford equalizer loop on return.
Foaming boiler	Action of water line	A jumping water line when boiler is operating indicates foaming caused by oil and dirt in boiler water.	Clean boiler with boiler cleaning compound.
Undersized boiler	Boiler rating against load total	Boiler may be large enough for radiator load but because of shortage of radiator surface it is not large enough for building. Or boiler may be overloaded.	Increase burner input or install larger burner to obtain faster steaming. Install copper coils in firepot. Operate with a lowered water line. Install larger boiler.
Vacuum equipment	Return of condensate to boiler	On vacuum jobs faulty action of pumps, traps or air eliminators will cause faulty return of condensate to boiler.	Clean and repair all steam specialties.

Complaint—Slow or Insufficient Heat in One or More Rooms

Possible Cause	Check	Details	Remedy
Insufficient radiator surface	Heat loss and radiator surface	Determine heat loss of room, divide by 240 and check against actual surface installed.	Paint bronzed radiators. Increase radiator size.
Poor circulation to radiator	Piping	Check branch and riser sizes, pitch of piping from main to radiator, connections to radiators, branches, mains and returns.	Correct pipe sizes, pitch and connections.
	Radiator valve	Check valve and nipple opening for possible clogging by rust or scale. Determine if valve seat has become loose and is only partially open.	Clean valves or nipples. Repair or replace faulty valves.
Poor radiator venting	Radiator vents	Check air vent under normal operating conditions to determine the speed of venting, if radiator is hot all over when venting stops, if vent leaks steam, and if vent is too high.	Clean. If radiator vents slowly replace vent with one with larger opening.
Trapped radiator	Slope of radiator	On one pipe system if radiator slopes down from opening too much condensate will remain in radiator. On two-pipe systems if radiator return is higher than inlet, condensate will flow back into riser on bottom inlet radiators and will collect in radiator on top inlet jobs.	Pitch radiators slightly in proper direction.
Radiator main flooded	Boiler return connections	If end of main is not elevated sufficiently above water line of boiler on systems not having a Hartford loop, condensate may flood end of main, preventing steam from entering end radiator.	Install a Hartford equalizer loop.
Faulty customer operation	Radiator valves	On one-pipe jobs, radiator valves may not be kept wide open causing condensate to be trapped while steam is on.	Instruct customer to keep valve wide open.
Faulty radiator traps	Radiator traps	Dirt or scale will interfere with trap operation.	Clean or install new traps.

GRAVITY CIRCULATION AIR SYSTEMS

Complaint—Slow or Insufficient Heat Throughout the Building

Possible Cause	Check	Details	Remedy
Insufficient heat input to furnace	Time required to raise register temperature to 140F	Average job should have living room register air temperature of 140F within 20 to 30 min. of time burner starts. Poorly circulating jobs should raise air temperature faster.	Increase input of burner.
Slow or sluggish circulation	Leader pipe sizes against heat loss	Determine heat loss of rooms and divide by 111 for first floor, 167 for second, and 200 for third to obtain leader area in inches. Add 2% to area for each foot over 12 ft. of length, 20% for each elbow over one, 10% for every turn over one.	Balance system with dampers. Increase input of burner.
	Wall riser sizes	Wall risers to second and third floors should have area of at least 70% of leader supplying them.	Balance system. Increase burner input. Add risers.
	Cold air returns	Total return duct area should at least equal total leader area. Drops to furnace should be of two 45° ells and round pipe rather than two 90° ells and rectangular pipe. Free area of grilles at least equal to area of duct.	Increasing burner input will overcome defects to some extent. Otherwise changes in returns will be necessary.
		Two returns joining will often cause unbalanced returning and poor air distribution to furnace.	Connect each return separately to furnace casing and balance return air.
	Cold air shoe connection to furnace casing	High point of cold air shoe should not be above the grate level or burner head level.	If shoe is above, protect top of shoe with deflector in upper part or install a radiation shield between firepot and casing extending down to below grate level.
	Number of returns	If only one return is used poor circulation is practically certain even if return area is equal to leader area.	Increase input of burner. Install additional return.
Furnace too small or too large	Furnace rating against heat loss	On undersized furnace an increased burner input is necessary to supply sufficient heat. On an oversized furnace somewhat greater burner input is necessary to heat up more metal and take care of radiation losses.	Increase burner input. Install correct size furnace.

Complaint—Slow or Insufficient Heat in One Room

Possible Cause	Check	Details	Remedy
Poor circulation	Leader pipes	Note whether leader has dents, is flattened or has air leaks. Check size. Leader size in square inches should be the heat loss of room divided by 111, 167, or 200 for first, second, or third floor, respectively. Add 2% to area for each foot over 12 ft. in length, 20% for each elbow over one, 10% for each turn over one.	Remove dents and flattening and seal leaks. If leader is long cover with good insulation. Install small fan in leader and control by room thermostat.
	Leader pitch and turns	Insufficient pitch and sharp turns will slow circulation.	If cold room is large and important, increase burner input and balance system. Otherwise, merely balance system. Increase pitch, insulate pipes.
	Wall riser	Riser to second or third floor room may have come loose from register boot allowing warm air to escape in wall.	Reconnect wall stack securely.
	Returns to furnace	Unequal distribution of return air in furnace will cut down on air flow to leaders located at points where small amounts of air are returned. This will often occur where only one return is used and where it is of non-flaring type.	Change return shoe to a flaring type with splitters. Change location of leader.
	Leader connection to furnace	On most furnaces there is little circulation at the front and leaders connected here will have poor air supply.	Change location of leader to other part of bonnet.
	Register area	Register free area should at least equal area of leader pipe supplying it.	Replace with register having proper free area.
	Leader pipes, boots and risers	A restriction in either leader, boot or riser will decrease circulation.	Provide full opening throughout run.
	Register location	Register should be on inside wall and direct air towards or along exposed walls.	Change location of register.
	Room location	Rooms on cold side of house may heat poorly even with proper size leaders and returns because of the effect of wind.	Add or increase size of cold air returns.
	Register and return grille location	Registers located too close to return grilles will cause short-cutting of air and poor room circulation.	Relocate registers or return grilles.
	Studding space	Where studding space is used to return air from second floor rooms it is necessary to block off space above grille to stop flue action which tends to carry air up to attic.	Block off studding space above grille.

Complaint—Cold Floors

Possible Cause	Check	Details	Remedy
Air stratification	Room temperatures at various levels	Air stratification may result when the burner is shut off and air circulation has stopped.	Shorten off-periods by using thermostat set for minimum differential.
Cold air traveling across floor	Return grille location	If return grilles are located on inside walls, cold air will travel across floor from the cold walls and windows.	Locate return grilles at outside walls.

FORCED CIRCULATION AIR SYSTEMS

Complaint—Slow or Insufficient Heat Throughout the Building

Possible Cause	Check	Details	Remedy
Insufficient input	Bonnet temperature	Bonnet temperature of at least 150F should be attained.	Increase input of burner.
Undersized furnace	Furnace rating against heat loss	Determine heat loss of building and check against rating of furnace.	Increase burner input. Install larger furnace.
System unbalanced	Room temperatures	Too much heat may be supplied to unimportant rooms and too little to important rooms.	Balance system with dampers in supply and returns.
Insufficient air delivery	Air volume	Air circulated may not be adequate to deliver enough heat or provide good heat distribution.	Increase speed of blower. Change blower size.
Dirty filters	Air filters	Dirty filters will decrease the amount of air circulated.	Clean or replace filters.
Poor design	Location of furnace	If furnace is located at one end of a long building, there may be a large temperature drop in the supply duct causing cold air to be delivered to end rooms.	Insulate duct and balance systems. Relocate furnace in center of building.
	Duct sizes	Incorrect size ducts and many bends will cause poor air distribution.	Increase input and air delivery. Balance system.

Complaint—Slow or Insufficient Heat in One or More Rooms

Possible Cause	Check	Details	Remedy
System unbalanced	Temperature in all rooms	If some rooms are overheated and some underheated it is necessary to decrease the flow to overheated rooms and increase it to underheated rooms.	Balance the system with dampers in supply and return ducts.
		If a number of rooms have the correct temperature while the rest are underheated, add more heat to the building.	Increase the burner input and balance the system.
Poor air distribution	Register location	If registers are improperly located the air will tend to stratify and cause cold floors. Registers should be on inside walls while return grilles should be on outside walls.	Try increasing air volume. Relocate registers and return grilles.
	Temperature of air from attic trunkline	Sometimes attic trunklines are used to supply upper floors. If the attic is cold the trunkline will be chilled. Also downward air currents from the attic may cool off riser to trunkline.	Insulate attic trunkline. Seal the shaft in which the riser is installed to prevent cold attic air from reaching the riser. Insulate the riser.

FORCED AIR SYSTEMS—CONVERTED FROM GRAVITY

Complaint—Slow or Insufficient Heat Throughout the Building

Possible Cause	Check	Details	Remedy
Insufficient heat input	Bonnet temperature	Bonnet temperatures of at least 150F should be developed.	Increase input to furnace.
Undersized furnace	Furnace rating against heat loss	Determine heat loss of building and check against rating of furnace.	Increase burner input. Install larger furnace.
System unbalanced	Room temperatures	Too much heat may be supplied to unimportant rooms and too little to important rooms.	Balance system by means of dampers in leaders.
Insufficient air volume	Air volume	Blower may not be capable of delivering required amount of air.	Increase speed of blower. Change blower size.
Inadequate return air	Size of grilles and return ducts	Return ducts may be too small or have too much resistance. Grilles may have too small a free area.	Increase fan capacity. Install larger ducts or grilles.
Unbalanced return air	Return air volume	It may be possible that one return is carrying more air than it should.	Balance returns.
Poor return connections	Return connections	Two or more returns should be connected into a manifold to the fan chamber and not enter furnace separately.	Connect all returns to fan chamber.
Poor furnace return connection	Furnace return connection	To even up air distribution in furnace a wide flaring connection with spreaders in it should be used to connect fan chamber to furnace.	Connect fan chamber to furnace with wide flaring connection with spreaders.

Complaint—Slow or Insufficient Heat in One or More Rooms

Possible Cause	Check	Details	Remedy
Unbalanced system	Temperature in all rooms	If some rooms are overheated and some underheated it is necessary to reduce air flow to overheated rooms and decrease it to underheated rooms.	Balance system with leader dampers.
		If some rooms have the proper temperature while the rest are underheated, it will be necessary to add more heat.	Increase the burner input and balance the system.
Poor air distribution	Number of registers and location	Registers located on outside walls or an insufficient number of registers will cause poor air distribution.	Increase fan speed and limit air volumes to other rooms. Provide additional registers. Relocate registers.
	Cold air return	An undersized or poor return will result in poor distribution.	Install a proper return.
	Leader size	Check leader size against calculated area. Large number of bends will cut down air flow.	Rebalance system. Eliminate unnecessary turns.
	Return grille location	Return grilles should be located on exposed walls. If located on inside walls they will cause cold, drafty floors.	Relocate grilles to exposed walls.

Absorption Cycle Refrigeration Modernizes Department Store

By D. M. MAYNE†

The W. H. Roland department store, Bloomington, Ill., cooled by an absorption cycle refrigerating machine.

CLIMAXING a $60,000 remodeling program, the W. H. Roland department store in Bloomington, Ill., installed equipment for complete year-round air conditioning of its main retail sales space. The first floor (8,100 sq. ft.) was completely modernized and the addition of air conditioning was made as an added comfort to customers and protection of merchandise against dirt and extreme humidity conditions.

Load calculations were based on an employed personnel of 30 persons and a customer traffic averaging 70 persons during maximum shopping activity. The lighting of the floor was by a combination of direct and indirect lighting representing a total load of 13.5 kw.

The total calculated sensible heat gain from people, lighting, transmission through walls and floors and solar radiation was 192,000 B.t.u. per hr. This necessitated the circulation of 8,600 c.f.m. to maintain a 78F room with an air supply at 58F. The circulation of 20% outside air for ventilation purposes represented a total calculated load of 22 tons refrigeration capacity.

Competitive bids were received on the installation and a survey was made of the proposals offered on the basis of a 10-year utilization and depreciation of equipment. The proposals were nearly identical from the standpoint of air distribution and general arrangement of the equipment. The equipment room being an inside basement room and quite inaccessible to the outside, all proposals figured on an atmospheric type water cooling tower on the roof of the building for the dissipation of heat. The major difference in the propositions was the refrigeration equipment itself, for two had included electric-driven compressor equipment and the third was based on using low-pressure steam absorption refrigeration.

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In making its survey of the proposals, the management of the store had several points to consider. To use the all-electric equipment would mean that a new power service and panel would be necessary in order to carry the additional load. New oil-fired steam boiler equipment which had been installed to heat the building was available to operate the absorption-type refrigeration equipment but the bid price on this type installation figured about 10% higher than for the other type equipment.

A study of operating costs convinced the management that in five seasons of operation of the absorption equipment, this higher first cost would be repaid, and that in the 10-year period which was used as a basis of the study, the service and replacement items on the absorption equipment would be low due to the freedom from mechanical wearing surfaces and parts. Consequently, absorption refrigeration equipment was installed. It has now operated through two seasons; its operating costs have been as estimated, maintenance has been low, and the maintained air conditions have been satisfactory both to the store and its customers.

Since this installation was made the manufacturer has made several slight modifications in the design of the equipment, and the discussion of the absorption refrigeration unit which follows in this article is based on current design.

Absorption Refrigeration for Air Conditioning

The absorption refrigeration system provides for both summer and winter air conditioning from the same source of energy—low-pressure steam. While this combination of equipment has long been realized as having many advantages in air conditioning work, absorption systems were frowned upon as long as ammonia was used as a refrigerant, due to the high pres-

sure, low thermal efficiency, large size per unit of refrigeration, the irritant, toxic, corrosive characteristics and chemical instability of ammonia.

The absorption refrigeration system, as used in the Roland store, has been devised for specific application to air conditioning. Low operating pressures, high thermal efficiency, chemical stability, non-inflammability, and freedom from corrosion, as well as low power requirements, silent operation and simplicity are claimed for this system which uses low-pressure steam as its source of energy. This unit is of necessity limited to the air conditioning field on commercial applications where coil temperatures of not less than 35F are required.

Essential Equipment

The following essential assemblies which make up the absorption refrigeration unit are indicated on the accompanying schematic diagram: *condenser,* in which the refrigerant vapor is condensed to a liquid; ***absorber,*** where the low-pressure refrigerant vapor is absorbed into solution; *solution pump,* which is a double pump unit driven by a single motor. One pump delivers the solution from the absorber through the heat exchanger into the heater; the other delivers the solvent from the heater and the heat exchanger into the absorber; *heater,* which serves to separate the refrigerant from the solvent; and *heat exchanger,* which consists of a series of double pass coils effecting a transfer in heat between the solvent returning from the heater to the absorber and the solution in going from the absorber to the heater.

Operating Cycle

The schematic diagram indicates standard operating pressures and temperatures and shows the cycle of operation, with methylene chloride as the refrigerant and dimethyl ether of tetraethylene glycol as the solvent.

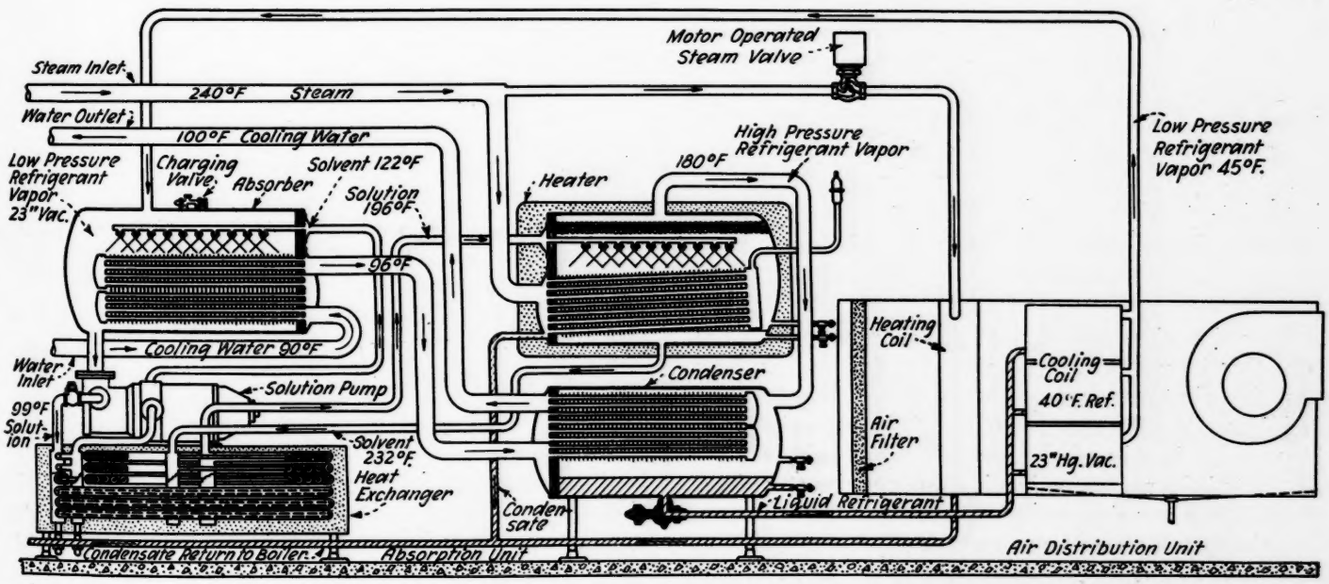
For the proper function of an absorption unit, the characteristics of the solvent and refrigerant must be such that the solvent has ability to absorb a large amount of refrigerant vapor at a relatively low temperature and pressure, and to give up this vapor freely at a relatively high temperature and pressure. The cooling water coil provided in the absorber removes heat from the solution so as to give maximum absorption ability. The steam coil in the heater raises the temperature of the solution to the point where the solvent gives up the major portion of the refrigerant. Therefore, the solvent might be referred to as a carrying agent for transferring the refrigerant from the low side to the high side of the system.

When there is steam in the heater coil, the absorption unit is put into operation by the cooling thermostat closing the circuit to the solution pump, which immediately starts the refrigeration cycle by circulating the solution from the absorber through the heat exchanger to the heater and the solvent from the heater through the heat exchanger to the absorber. The solvent or weak solution moving from the heater to the absorber is delivered over the water coil in the absorber by means of a nozzle assembly, and the solution moving from the absorber to the heater is likewise delivered over the steam coil by means of a nozzle assembly.

The resultant absorption of refrigerant vapor in the absorber by the solvent produces a corresponding reduction in pressure in the low-side cooling coil. The reduction in pressure permits the evaporation of liquid refrigerant through the cooling coil with the corresponding absorption of heat from the air to be conditioned. The low-pressure gas then flows by means of the reduced pressure to the absorber where it is absorbed into solution by the solvent.

The solution leaving the absorber and delivered through the heat exchanger and the heater nozzles by the pump is then sprayed over the steam coil in the heater where the refrigerant is distilled from the solvent. The solvent then drains out of the bottom of the heater and the pump delivers it back through the heat exchanger and absorber nozzles to complete its cycle.

The refrigerant vapor in leaving the heater passes



Arrangement of essential apparatus and expected temperatures in the absorption cycle described here

to the condenser where it is condensed into a liquid and fed through the liquid line where it is subject to the action of the refrigeration control device on the low-side cooling coil.

As long as the system is in operation, there is a continual process of vaporization of the refrigerant in the cooling coil with a corresponding absorption of heat, and continual transformation from vapor to liquid in the absorption unit with a corresponding dissipation of heat.

Operating Requirements

The absorption refrigeration unit dealt with in this article is designed to operate on a steam pressure of 10 to 13 lb. Other pressures may be used, but the capacity will vary with the steam pressure, although the thermal efficiency of the unit remains practically constant. With steam pressures above 20 lb. per sq. in. gage, the use of a pressure reducing valve is recommended. The heat input required is 20,400 B.t.u. per hr. per ton, under the standard operating conditions as indicated on the schematic diagram. This is equivalent to 21.4 lb. of steam, 0.2 gal. oil, or 0.284 therms of gas based on 72% boiler-burner efficiency. A coal-fired boiler operating at 57% efficiency requires 3 lb. of average bituminous coal (12,000 B.t.u. per lb.) to produce the necessary amount of steam to meet the ton-hour heat requirement.

The cooling water requirements for the absorption units are based upon a heat dissipation of 534.6 B.t.u. per min. per ton at the standard operating conditions as set up on the schematic diagram. This requires the circulation of 6.4 gal. of water per minute per ton with a 10F temperature rise in the water. It will be noted that while the heat dissipated in the water is 534.6 B.t.u. per min. per ton, the steam input is 340 B.t.u. per min. per ton.

The only electric power requirement of the absorption unit is that of the motor-driven solution pumps. One pump must deliver approximately 1.1 gal. of solution per minute per ton from the absorber to the heater and 0.85 gal. of solvent per minute per ton from the heater to the absorber. (The difference in gallons is accounted for by the amounts of refrigerant carried in solution.) To accomplish this pumping requirement a pump of the centrifugal type is used. Motor requirements are 1 hp. on units from 5 to 10 tons rated capacity and 1½ hp. on units from 12 to 25 tons rated capacity. The difference in power requirements per ton between the large and small units is due to the inherent efficiency characteristics of the type pump used.

Characteristics

Operating characteristics of the absorption unit are such that its performance is very definitely affected by variations in steam temperatures, water temperatures, and low-side coil temperatures. The ratio between fluctuations in any of these conditions can be readily set up and the performance of the unit under any given set of conditions determined.

Variations in steam temperatures affect the performance of the unit. Since 240F steam is the basis of the nominal rating, by maintaining constant water and low-side coil temperatures a variation of 1F above or below 240F will produce a variation of approximately 1% above or below rated capacity. This ratio holds within limits of 20F, and for general application it is recommended that 230F to 260F be considered as the lower and upper limits, respectively. This represents an approximate variation in corresponding pressures of saturated steam of from 6 to 21 lb. per sq. in. in gage pressure.

The capacity of the absorption refrigeration unit is dependent upon the temperature of the water supply; 90F inlet and 100F outlet water temperatures have been established as standard conditions for the normal rating. The following capacity table indicates variations in capacity based on 100% at the standard condition. These variations are predicated on a constant steam temperature at 240F and low-side coil temperature of 40F. The table also indicates variations in amount of steam required per hour per ton at the various operating conditions.

Water Temperature, °F		Capacity, %	Steam, Lb. per Ton-Hr.
In	Out		
80	90	120	19.6
85	95	110	20.4
90	100	100	21.4
95	105	89	23.0

The low-side pressure and resultant refrigerant boiling temperature is the third factor which directly affects the capacity of the unit. A unit producing 100% rated capacity while operating on 240F steam, 90 to 100F water and 40F low-side will produce approximately 118% capacity while operating at 45F low-side with other conditions remaining the same. This represents a change in capacity of roughly 3½% per degree Fahrenheit variation in the low-side coil temperature.

Variations in the type of equipment furnished with the absorption refrigeration unit have been a step toward widening its field of application. The increased usage of evaporative condensers in the air conditioning industry leads to a natural development of the absorption type equipment. The condenser surface is placed in a unit similar to the conventional evaporative condenser with an additional set of water nozzles placed below the condenser coil. The water is circulated from the sump of this unit through the absorber and is then discharged through the nozzles in the evaporative condenser unit where the heat of condensation is dissipated by direct surface evaporation and the additional water nozzles serve to remove the heat of the absorber by evaporation such as is accomplished in a forced draft water cooling unit.

A more recent variation of the absorption refrigeration unit permits the application of direct gas flame as the source of energy rather than steam.

Operating Costs

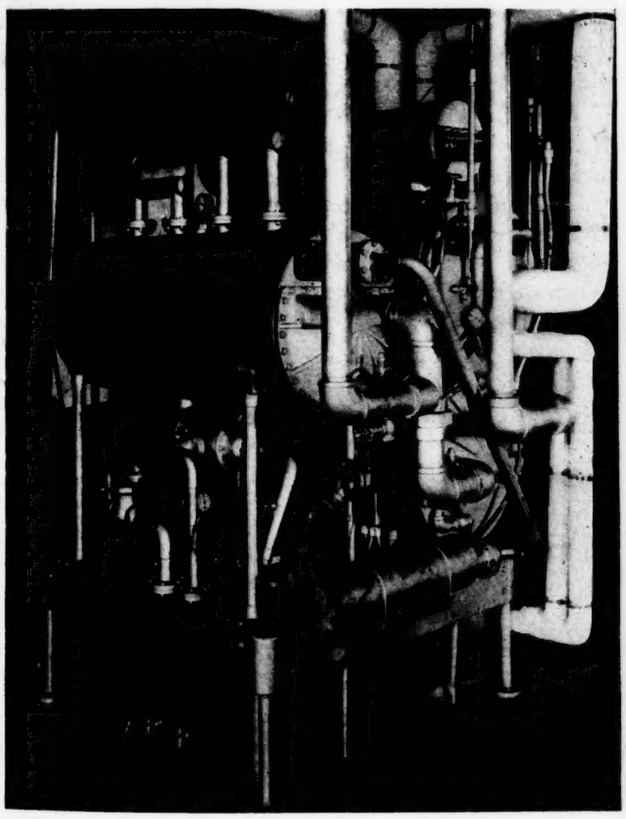
Operating cost is a matter of considerable interest in air conditioning and in many instances the absorption system of refrigeration may be demonstrated to have a distinct advantage in this respect. Local utility rates are the ultimate criterion of operating costs. At

15-Ton I.M.E. Absorption Refrigeration Unit	
Steam	
15 Tons @ 0.2 gal. fuel oil per ton-hr. @ $.07 per gal.	$.21
Solution Pump—15 Tons. 1.3 kw. per hr. @ $.025	.0325
Additional Water Pumping Requirement	
1.5 brake-hp. 1.4 kw. per hr. @ $.025	.035
Total hourly cost of operation	$.2775

15 Ton I.M.E. Compression Refrigeration Unit	
Electric Requirement	
15-Ton Unit Producing at Rate of .95 Ton per kw.-hr.	
Requires 15.8 kw. per hr. @ $.025	$.395
Total hourly cost of operation	$.395

any given set of operating conditions and utility rates, comparative operating cost values may be set up. The above table indicates operating costs of a 15-ton Ice Melting Effect absorption unit operating with 90-100F cooling water, 240F steam and 40F low-side and also for a compression type refrigeration unit operating with 90F cooling water and 40F low-side temperature. These costs are based on electric costs of 2.5c. per kw-hr. and 30 Baume gravity fuel oil at 7c. per gal. being burned at 72% boiler-burner efficiency.

Observations on calculations made over a number of installations using conventional atmospheric type water cooling towers indicate that the additional water cooling requirement for the absorption refrigeration system as compared to the compression type equipment necessitates additional power in the water circulating pump of approximately 0.1 brake-hp. per ton. A 15-ton unit would then require 1.5 brake-hp. for water circulating purposes in addition to that required by the compression type of equipment and in order to draw a true comparison of operating costs this additional load is included with the operating cost of the absorption refrigeration unit.



Absorption type refrigerating unit described in this article similar to that installed in the Roland store

As will be noted from the foregoing table, an hourly difference of 11¼c. per hr. of full load continuous operation will be required by the compression type of refrigeration as compared with the absorption type which in percentage is an additional hourly cost of approximately 40%. Based on a seasonal operation of from 800 to 1000 hr., this difference would represent an annual saving of from $90 to $110 by using the absorption type of equipment. In addition to this difference, there is often encountered a rate schedule by which a service demand charge is imposed which would show as an advantage for the absorption refrigeration system. This comparison will vary widely with various utility rates and operating conditions.

Operating costs must be weighed against installation costs in order to obtain a true picture of the economy of the absorption refrigeration system. The actual equipment costs to a contractor for the absorption system are within less than 5% of the average cost to a contractor of compression types of equipment The absorption equipment, however, requires slightly more assembly work on the job.

The large water cooling requirements impose another slight penalty on the contractor due to the increased size of water cooling equipment necessary for the dissipation of this heat. The relatively high water temperatures which may be used with this equipment, however, tend to compensate for the large number of gallons in such a way that the cost of the water cooling equipment does not increase in proportion. The type of water cooling equipment used and its location are factors influencing this cost.

Field of Application

The field of application of the absorption refrigeration system is wide and the citing of several examples where a distinct advantage may be demonstrated by its use will undoubtedly call to the minds of readers other specific applications as well as the almost universal usage which is practical for this equipment in the air conditioning field.

The absorption refrigeration unit finds its best application in the air conditioning field on projects requiring equipment capacities of 50 tons or less. Absorption refrigeration equipment is available in sizes ranging from 5 to 25 tons, it being impractical to furnish sizes larger than 25 tons in a single unit. On installations requiring larger than 25 tons capacity, more than one unit is used. However, the large volume of air conditioning business will fall within the range of this equipment.

To the contractor or engineer interested in complete year-round air conditioning in the residential or small commercial field, the absorption refrigeration unit has a particular appeal. A small automatic fired boiler-burner unit which is large enough to heat the average building in average central United States climates will be amply large to provide cooling in the summer for the same building through the absorption refrigeration system, thus forming a well-balanced, year-round load for the equipment.

Effect of Design and Operation Changes on the Capacity of an Evaporative Condenser

By H. C. ROOKS†

In a previous article there was discussed the temperature relationship between the three fluids, air, water, and refrigerant, as they pass through the evaporative condenser. It was brought out that the spray water is the important factor in evaporator condenser operation, that it makes possible the operation on a wet bulb basis and results in a high heat transfer between the refrigerant and air. In this article there is discussed the effect of changes in design and operation procedure on the capacity of the condenser. Included is information on the effect of type of coil header, coil depth, and air volume on the capacity of the unit as well as a discussion on factors affecting the amount of make-up water required.

THERE are two principal types of headering used in evaporative condenser units. In the first type liquid is removed after every other row of tubes and the remaining gas enters the row of tubes directly below. Removal of the liquid in this manner prevents the formation of an insulating layer of liquid along the bottom of the tube, thereby preventing a decrease in the capacity of the coil. In the second type, a continuous circuit is used; the gas enters either one or two rows at the top and the liquid drains out of the bottom tubes.

Although the heat transfer is improved somewhat with the former type of construction, the headering is comparatively expensive and difficult to install. Generally the increase in capacity of the condenser is not sufficient to warrant the additional cost and complex piping of the first type of headering.

With continuous tube circuits of the second type of headering, some subcooling can frequently be obtained in the last row of tubes of the condensing coil. In steam coil performance, it is generally accepted that the condensate in a comparatively long length of coil is cooled beyond the condensing temperature of the steam. This also occurs in an evaporative condenser coil of similar design. Results of tests are noted in Table 1. This coil was only 3 ft. long and approximately 3 to 5F of subcooling were obtained in the last row. With a longer coil, the liquid subcooling in the last row will be greater.

The number of circuits used in a coil of the continuous circuit type must be such that the velocity of the refrigerant vapor will be sufficient to prevent the formation of an insulating layer along the bottom of the tubes in the upper rows.

TABLE 1

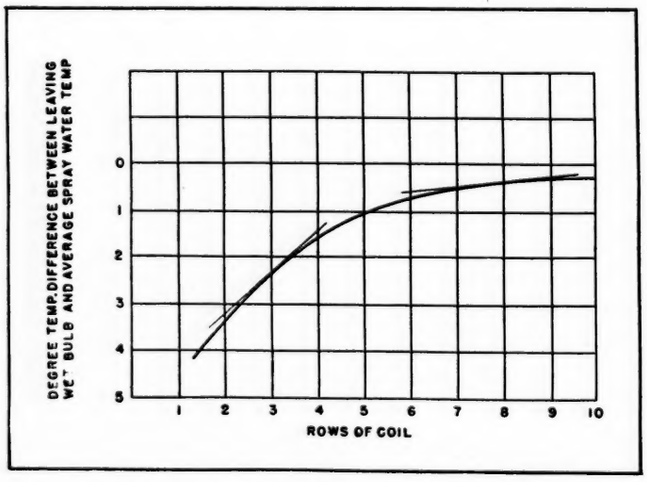
Test No.	23	24	25	26	27	28	29
Condensing temp. of refrig. vapor, F. ...	100.0	103.0	105.8	110.0	93.2	91.6	96.8
Liquid temperature leaving coil, F.	96.6	99.9	102.3	106.2	88.6	87.7	93.1
Subcooling, deg. F. ..	3.4	3.1	3.5	3.8	4.4	3.9	3.7

Effect of Coil Depth

The rate of heat removal per square foot of surface will limit the economical depth of coil or number of rows to be used in an evaporative condenser.

As the number of rows of tubes is increased, the difference between the temperature of the spray water and the wet bulb temperature of the air becomes smaller for any given set of conditions. For each row added, the decrease in this temperature difference per additional row becomes smaller. Eventually a point is reached where the decrease for an additional row is so small as not to warrant increasing the depth of the

†The Trane Co.



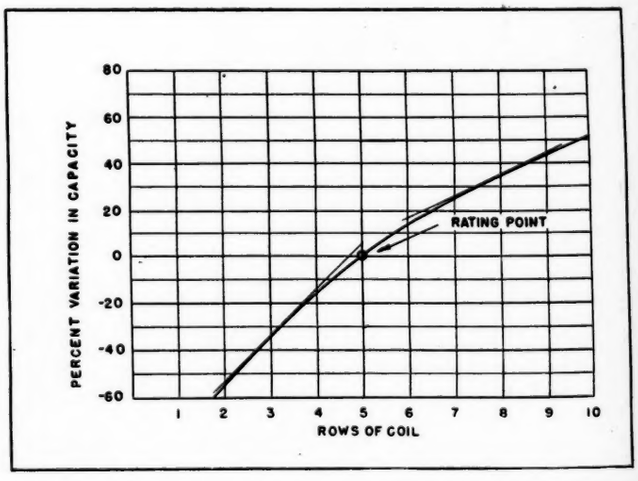


Fig. 1. (Left) Effect of coil depth on temperature difference between leaving wet bulb and average spray water temperature.
Fig. 2. (Right) Effect of coil depth on capacity under an average operating condition.

coil any further. Referring to Fig. 1, note that beyond eight rows the temperature difference between the spray water and the leaving wet bulb temperature is less than one-half a degree. Any further increase in the number of rows will, therefore, have little effect on the rate of heat removal from the refrigerant to the spray water; the heat absorbed by the air is almost equal to the maximum possible quantity. The curve levels off sharply above five rows as can be seen by comparing the tangent to the curve at three rows and eight rows. This indicates that below about five rows an increase in the coil depth not only increases the heat transfer from the refrigerant to the spray water but also from the spray water to the air.

The effect of this temperature difference on the total capacity can be noted on Fig. 2. The rate of increase in capacity drops off above five rows, as is to be expected. Tangents to the curve at three and eight rows illustrate this. The optimum coil selection, therefore, occurs above three rows and below eight rows.

It should be emphasized that the points noted on Figs. 1 and 2 apply only to one particular type of coil design. A change in the ratio of external to internal surface or the amount of surface per row will materially affect the optimum coil depth, although the general characteristics will be the same.

Effect of Air Volume

The air velocity affects only the rate of heat transfer from the spray water to the air. Under the same operating conditions, an increase in air quantity will reduce the leaving wet bulb temperature of the air. This will reduce the spray water temperature because the wet bulb temperature of the air will be lowered by the increase in the volume of air supplied. This results in an increase in the capacity of the condenser.

Fig. 3 shows the effect of a variation in velocity on the capacity of a unit for a given set of operating conditions and coil surface with an assumed relation of secondary to primary surface. By comparing Fig. 3 with Fig. 2, it can be noted that an increase in air velocity has considerably less effect on capacity than an increase in coil depth. As previously mentioned, this is due to the fact that the air velocity affects only the heat transfer coefficient between the spray water and the air.

The condensing temperature determines the capacity of a coil by limiting the leaving wet bulb temperature. By increasing the air velocity, the capacity of the condenser is increased because the additional air absorbs additional moisture. However, this effect is not the same at all air velocities. This is evident from the tangents drawn to the curve at 300 and 800 ft. velocity in Fig. 3. This curve indicates that the optimum velocity lies between 400 and 800 f.p.m.

The air friction through the coil at various velocities is an important item which must be taken into consideration in selecting the correct air velocity when designing a condenser. With increasing velocities, the increase in power is out of all proportion to the increase in capacity. Therefore, in selecting the most economical air velocity it is necessary to take into consideration both coil capacity and air friction through the coil.

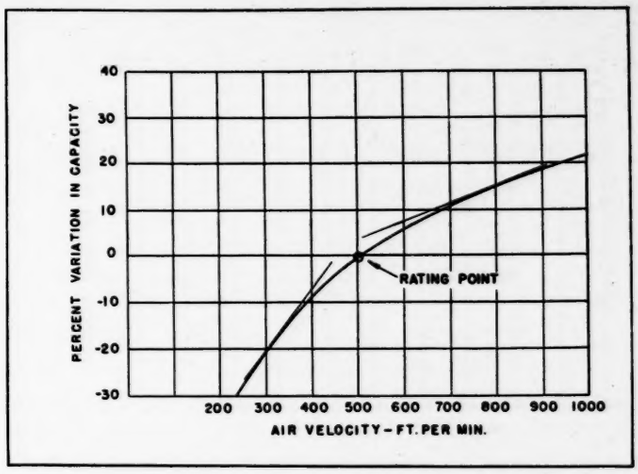


Fig. 3. Effect of air velocity on capacity under an average operating condition.

Head Pressure

Evaporative condensers cannot be accurately rated on the basis of head pressure. This is due to the fact that there are some noncondensable gases in every system. Because of this, the actual head pressure noted on the high pressure gage will be higher than the pressure corresponding to the condensing temperature. Table 2 gives test data on a condenser in which the difference between the actual head pressure and the pressure corresponding to the condensing temperature is approximately 15 lb. This is a result of incomplete purging of the system.

Table 3, however, shows other tests where the purging was more complete. The pressure difference in this case is only from 3 to 5 lb. From the foregoing, it is apparent that condenser ratings should not be based on head pressure.

In testing the evaporative condenser, therefore, condensing temperature should be read by means of thermometers installed on the coil or thermocouples inserted within the coil which will indicate the actual condensing temperature of the refrigerant.

Make-up Water

Most evaporative condensers are so rated that each unit has a specified quantity of make-up water which is assumed to be used in the operation of the evaporative condenser. However, actual operating conditions affect the quantity of water used by a given evaporative condenser. Fig. 4 is an example of an evaporative condenser operating under two conditions. As can be noted in this chart, the entering condition in the first case is 85F dry bulb and 75F wet bulb, and in the second

TABLE 2*

Test No.	23	24	25	26	27	28	29
Head pressure as read, lb. per sq. in.	125.0	131.0	137.0	145.7	112.0	110.0	119.0
Condensing temperature, F.	100.0	103.0	105.8	110.0	93.2	91.6	96.8
Pressure corres. to cond. temp., lb. per sq. in.	110.8	116.6	121.0	128.4	97.2	95.8	104.8

*Approximate difference between actual head pressure and the pressure corresponding to condensing temperature is 15 lb. per sq. in.

TABLE 3*

Test No.	4	5	6	7
Head pressure as read, lb. per sq. in.	93	98	104.0	126.0
Condensing temperature, F.	82	95	90.0	103.0
Pressure corresponding to condensing temperature, lb. per sq. in.	87	92	99.5	122.5

*Approximate difference between actual head pressure and condensing pressure is 5 lb. per sq. in.

case, 120F dry bulb and 75F wet bulb. In both cases, it was assumed that the leaving condition was the same, that is, 85F wet bulb and approximately 93F dry bulb. In the first case, approximately 60 grains of moisture are evaporated into the air in removing the total load. In the second case, approximately 110 grains of moisture are used in removing the same load. Actually the air will not leave the unit with as high a relative humidity in the second case as in the first case. However, for the sake of simplicity, this is assumed to be true. The net result is that the water evaporated into the air is nearly doubled in the second case compared to that of the first. Instances of such operations have occurred in railroad service where the car is in a comparatively moist atmosphere one day and in a dry area the next day.

The heat removal in evaporative condensers is obtained through evaporation of the moisture in the air so that the make-up water quantity is greatly increased in the latter case. This increase in moisture or make-up water requirements is caused by an actual drop in the dry bulb temperature of the air passing through the condenser, resulting in the evaporation of the additional moisture. In all evaporative condenser applications, it is also necessary, in spite of the fact that eliminators are used, to add to the calculated make-up water requirements for entrained moisture which is carried through the unit and discharged to the atmosphere.

In the foregoing discussion the following points were stressed: First, that the spray water is the important factor in evaporative condenser operation. It makes possible the operation of the unit on an air wet bulb basis. It also adds to the heat transfer coefficients involved in the operation of the unit and greatly affects its design.

Second, the necessity of properly designing the coil. The ratio of prime to secondary surface together with

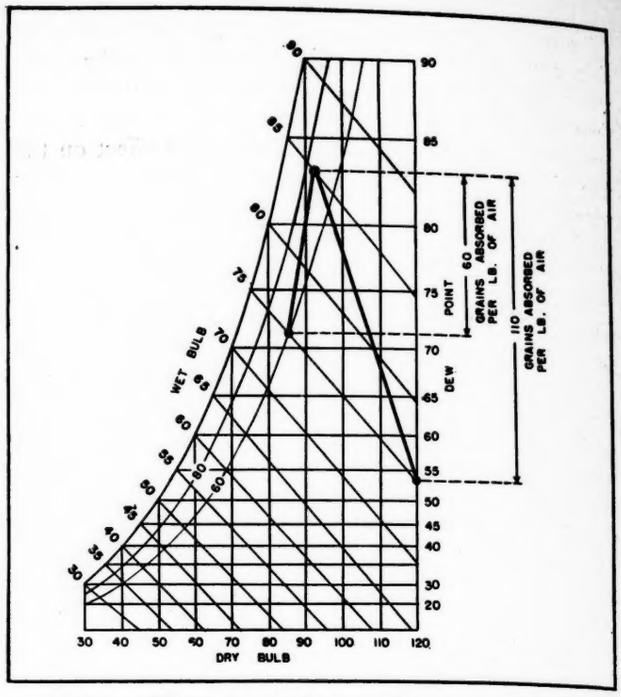


Fig. 4. Effect of entering conditions on make-up water required.

the total surface in a unit determines its capacity under a given set of conditions. The total surface alone is no definite indication of the unit capacity. The method of headering used in the coil also has a definite bearing on the capacity.

Third, the effect of air velocity and coil depth. The optimum coil depth and air velocity is dependent largely on the proximity of the spray water temperature to the leaving wet bulb temperature of the air.

Fourth, the variation in make-up water requirements. Although the capacity of a unit is based on the entering air wet bulb temperature only, the make-up water required by the unit is also dependent on the dry bulb temperature of the entering air.

The information in this article is based on data obtained both in the laboratory and in the field over a period of time. This work has been made possible through the effort of R. H. Anderegg to whom the writer is indebted for his assistance and suggestions.

Air Conditioning Reduces Post-Operative Pneumonia

DISCOVERY that air conditioning apparently eliminates 99% of post-operative pneumonia is reported at Corey Hill Hospital, Brookline, Mass.

Rigid control of humidity, which was kept constantly low at 30%, compared with the 50 and 60% humidities which have accompanied scorching weather this summer, appeared to be fully half the cause of improved vigor.

Lung trouble is one of the risks of surgical operations for which no satisfactory preventive heretofore has been found. It happens after 6 to 7% of operations, according to a survey made by the Massachusetts General Hospital. Most frequently these complications appear after operations on the stomach, gall bladder and intestines, and twice as often among men as women.

But at Corey Hill, with air conditioning in all bedrooms, operating rooms, and solarium, 743 operations in a year resulted in only one case of post-operative pneumonia. Recovery in this case was quick. The "weather" experiment is described by the hospital's medical director, Dr. Albert G. Young, in "Hospitals," the official magazine of the American Hospital Association.

The humidity was maintained at 30 with a margin of not more than 2%. The only exception was during operations, where the humidity was lifted to about 55 to protect against possible explosions of anesthetic gases. As the pneumonia does not develop until two or three days, the operating room humidity did not appear to be a factor in the lung troubles.

Orificing of Gate Valves

By CHARLES O. RADDEN†

WHETHER steam is purchased from a central plant or generated on the premises, the economy of heating system operation depends on the efficiency of distribution and the effectiveness of control. Installing orifices is a long-established method of distributing steam in the right quantities to the various radiators without having steam blowing through into the return line. The orifice is usually a thin brass plate containing a small hole. It is installed in the inlet of each direct radiator.

The installation of properly sized orifices will result in reduction of complaints from overheating or underheating, and there will be a resultant economy in steam consumption. The demand of the heating system on the generating plant will also thereby be reduced.

Connected with the orificing of a heating system are two engineering problems: sizing of the orifices and installation of the orifices.

The size of the hole in the orifice plate is determined:

1. By the weight of steam that must be condensed in the radiator to maintain the room at the desired temperature.

2. By the difference between the steam supply pressure and the return line pressure.

The amount of steam required to heat the space is found by heat loss calculations for average minimum temperatures. The pressure differential for the orifice design is somewhat arbitrary, depending upon the required degree of quietness of operation and the type of heating system. A large pressure differential will result in a fairly loud whistling noise which may be augmented by the type of radiator column; however, the large pressure differential has the advantage of more accurate control of steam flow due to the wider range for pressure modulation. Limiting factors in pressure difference may also be the length of loop seals on risers and whether the system has a vacuum pump or gravity return. A small differential, while quiet, is fairly difficult to modulate accurately with varying outdoor temperatures. We have found a design differential of 3 lb. to be satisfactory in most respects.

The second problem, that of installing these orifices, is affected by the type of radiator valves installed in the heating system, and by the accessibility and flexibility of the radiator connections. If radiator valves are provided with unions, as occurs in all the newer buildings, a thin disc-shaped orifice can be inserted between the faces of the unions (Fig. 1). When small pipe sizes are used for radiator connections, the union faces may be sprung apart easily and the orifice inserted.

Where we have found older buildings with radiator valves of the globe or gate type, without unions, we have had to make up special types of orifices to fit within the valve bodies. Our experiences with the globe valve orifice appeared in the February, 1938, issue of HEATING & VENTILATING.

Since then we have improved our methods and our tools, using the tool shown in Fig. 2 to expand the orifice in place. Here a cam is rotated within the slotted tool to provide the spreading force. The orifice can be spread quickly with the amount of spread controlled.

For all valves without unions, we have machined from brass rod a thin walled plug, sized to fit within the inlet seat of the valve. The metal of the wall is then forced out to form a ring, locking the plug into

†Engineer, Steam Service Section, Boston Edison Company

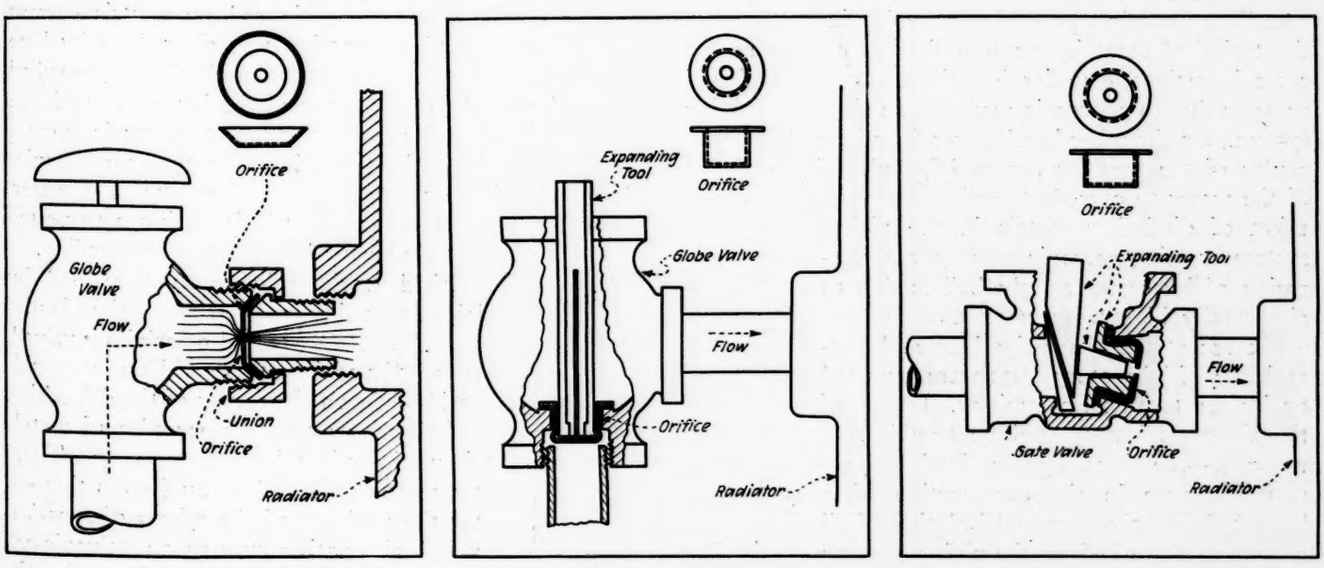


Fig. 1. (Left) Orifice inserted in union—a method readily used with small pipe sizes. Fig. 2. (Center) Orifice inserted in seat of radiator valve and fastened by special expanding tool. Fig. 3. (Right) Method of inserting orifice in gate valve with expanding tool used to fasten it.

place. In most cases, the valve becomes tighter in closing due to the face of the soft brass plug acting as a new seat for the disc or the wedge.

For inserting and locking the gate valve plug in place, a tool was required that would work in the small space between the faces of the seat. A solid tool steel plug was turned to conform to the inside shape of the expanded orifice. A tapered hole was drilled and reamed through the center of the plug. The plug was then slotted to collapse and fit within an unexpanded orifice. A tapered expanding plug was turned to fit within the tapered hole. This plug was made short enough to be inserted in the small space available with room for a pair of wedges to be driven against the solid plug, forcing the slotted plug apart. Three or four blows with a light hammer are enough to set the orifice firmly in place.

Fig. 3 shows the type of orifice used, and the valve tool and orifice in place.

Tests were made on this orifice inserted in the valve seat without a sealing compound. A blank orifice was subjected to 22 lb. steam pressure without being dislodged, although steam seepage did occur. This blank orifice, however, was as tight as the average closed gate valve. Since these gate valves are forty years old, the effectiveness of the seating surface has now been improved by the flanged face of the orifice forming a new seat.

In comparing these types with the standard thin-plate orifice, the outstanding difference occurs in the labor required for installation. To pry apart some union connections and to shift heavy radiators is a job for two men who may spend fifteen or twenty minutes on one radiator, especially where the radiator hangs on or supports the runouts, In addition, their noise and dirt are sure to be annoying to the building tenants. Contrast this with a method where one man may remove the radiator valve bonnet and insert the orifice at a rate as high as thirty per hour. Obviously there are savings possible.

Why Pipe Lines Cause Trouble

SIGNIFICANT factors contributing to trouble with pipe lines on which electrical current has been grounded have been discovered by a technical committee carrying on field investigations and technical studies for the American Research Committee on Grounding, reports "Industrial Standardization." The American Research Committee on Grounding is making a study of the grounding provisions of the National Electrical Code to determine whether changes are necessary, and the findings of the technical committee will be used by the American Research Committee in making its decisions.

There is no evidence that the current may not have contributed to the cause of the trouble in some cases, the technical committee reported, but in none of the cases investigated so far has the trouble been found actually due to alternating current on the water-piping system. On the other hand it was found that important causes of the troubles reported included the tendency of the water to corrode the piping or other metal, the effect of dissimilar metals in the piping system creating galvanic couples, and corrosion of hot-water supply boilers due to abnormally high temperatures.

Six recent field investigations and several sets of laboratory tests were reported on by the technical committee. In one of the six cases investigated no trouble was reported—the investigation having been made because in the construction of a large building the electrical isolation of all protective grounds from the piping systems had been attempted. Electrical tests and inspection showed, however, that such isolation had not been attained.

In the second case reported, the complaint was of leaky water-pipe joints, and the trouble was apparently due to a combination of high water pressure and poor workmanship in the original installation.

In another case where the complaint was of a failure of boiler tubes, steady readings of small direct current were obtained at the boiler, indicating galvanic action. On the pipes and grounding conductor close to the service entrance the readings were small and fluctuating, indicating stray electric-railway currents.

In the three remaining cases the complaints were of discoloration or other impairment of the quality of the water delivered through taps on customers' premises. Of these three cases one showed no electric current present on the pipes, another was cleared up by lime treatment of the water, and the third was remedied by reducing the temperature of the hot water to 140F.

Additional field investigations are to be made as cases are reported to the committee by water companies where troubles such as corrosion, impairment of water, sparking, or electrical shock are suspected as being caused by electrical grounding.

Field work is being supplemented by laboratory investigations of the fundamental electro-chemical principles involved. It is believed that these will throw considerable light on the causes of the difficulties.

Laboratory tests on samples of metals simulating pipes have been made. These tests have indicated many factors that enter the problem of the effects of superimposed alternating current on galvanic-cell current, and further tests to determine the fundamentals involved are being undertaken.

Relative Humidity in July

Definitions

The moisture in the atmosphere is usually referred to as humidity, and its amount may be expressed as absolute or relative.

Absolute humidity refers to the actual amount of moisture, expressed as vapor pressure, or as the actual weight of vapor in a given unit of space. Relative humidity refers to the relation that exists between the actual amount of moisture present in the atmosphere and the amount that could exist under the same conditions of temperature and pressure without condensation. This term, however, gives no indication of the actual amount of moisture in the atmosphere, as the capacity of the vapor of water to exist as such without condensation is almost wholly a function of the temperature.

Engineers (but not meteorologists) compare the quantity of moisture in a given unit of the atmosphere to the quantity of dry air in the same unit; the expression "grains of water per pound of dry air," for example, being termed the absolute humidity.

The absolute humidity is not so important a climatic factor as the relative amount of moisture in the atmosphere, since it is the latter that affects organisms and determines whether the physical climate of a place is moist or dry.

Variation in Relative Humidity

The variation in the relative humidity of a place therefore depends not alone on the actual amount of water vapor present in the atmosphere but also and principally on its temperature.

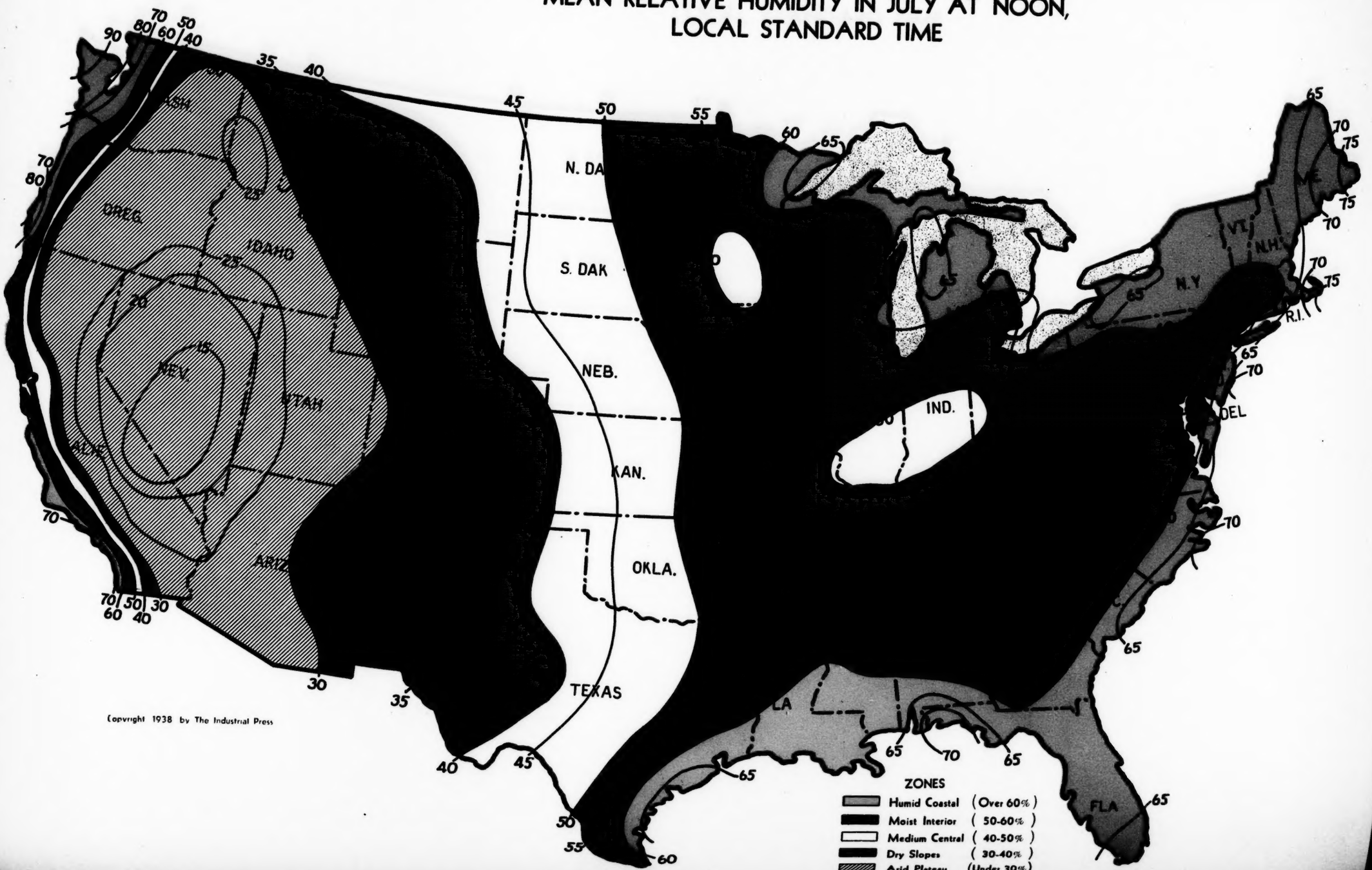
Climates recognized as "dry" are not necessarily deficient in actual moisture, since even in desert regions the amount of moisture in a given unit of space may equal or even exceed that in other districts commonly considered as moist. Thus at Yuma, Ariz., a place frequently referred to as among the driest in the United States, there is, in July, as a rule, as much moisture in the atmosphere as at points on the Great Lakes, where the climate would ordinarily be referred to as moist. However, on account of the high temperatures at Yuma in the warm period of the year, the opportunity for water vapor to exist is greatly increased, the relative humidity becomes very low, the climate is considered dry, and any water exposed is quickly evaporated. On the other hand, in the lake region, the lower temperatures lessen the amount of vapor that can remain in the air and consequently it is more nearly saturated; there is less opportunity for evaporation and the climate is relatively moist.

The Map

In the accompanying map is shown the average relative humidity throughout the United States as measured at noon local time. Since

Text continues following Map and Table.

MEAN RELATIVE HUMIDITY IN JULY AT NOON, LOCAL STANDARD TIME



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MEAN RELATIVE HUMIDITY AT NOON IN JULY IN 100 CITIES

City	8 a.m. East. Stand. Time	Noon Local Stand. Time	8 p.m. East. Stand. Time	Time Zone
Albany, New York	75	57	67	E
Albuquerque, New Mexico	64	–	36	M
Asheville, North Carolina	88	56	74	E
Atlanta, Georgia	82	57	68	C
Atlantic City, New Jersey	81	73	83	E
Baker, Oregon	62	36	31	P
Baltimore, Maryland	71	53	66	E
Birmingham, Alabama	83	55	69	C
Bismarck, North Dakota	80	46	50	M
Boise, Idaho	54	26	21	M
Boston, Massachusetts	71	66	72	E
Buffalo, New York	76	70	70	E
Burlington, Vermont	75	61	–	E
Charleston, South Carolina	79	67	80	E
Charlotte, North Carolina	81	55	68	E
Cheyenne, Wyoming	69	40	42	M
Chicago, Illinois	75	58	65	C
Cincinnati, Ohio	75	52	58	E
Columbia, South Carolina	82	58	68	E
Columbus, Ohio	77	53	60	E
Concord, New Hampshire	79	62	–	E
Dallas, Texas	76	48	–	C
Denver, Colorado	65	35	38	M
Des Moines, Iowa	78	51	55	C
Detroit, Michigan	73	53	61	E
Dodge City, Kansas	78	43	47	C
Duluth, Minnesota	81	70	68	C
El Paso, Texas	60	33	30	M
Erie, Pennsylvania	71	64	67	E
Evansville, Indiana	76	49	56	C
Flagstaff, Arizona	73	–	42	M
Fort Smith, Arkansas	81	53	58	C
Fort Wayne, Indiana	77	51	58	C
Grand Rapids, Michigan	74	47	54	C
Greenville, South Carolina	80	58	68	E
Harrisburg, Pennsylvania	74	53	64	E
Helena, Montana	62	36	33	M
Houston, Texas	88	57	–	C
Indianapolis, Indiana	72	49	57	C
Jacksonville, Florida	83	63	78	E
Kansas City, Missouri	76	51	55	C
Knoxville, Tennessee	83	55	67	C
Lexington, Kentucky	77	56	67	C
Lincoln, Nebraska	78	48	51	C
Little Rock, Arkansas	82	53	62	C
Los Angeles, California	88	55	60	P
Louisville, Kentucky	74	51	57	C
Macon, Georgia	82	56	69	E
Madison, Wisconsin	78	59	61	C
Memphis, Tennessee	80	59	65	C
Meridian, Mississippi	85	54	69	C
Milwaukee, Wisconsin	74	61	66	C
Miami, Florida	75	68	76	E
Mobile, Alabama	84	63	76	C
Nashville, Tennessee	79	51	61	C
New Haven, Connecticut	71	62	74	E
New Orleans, Louisiana	83	63	73	C
New York, New York	75	59	69	E
Norfolk, Virginia	81	60	76	E
Oklahoma City, Oklahoma	80	48	54	C
Omaha, Nebraska	75	52	53	C
Parkersburg, West Virginia	79	73	66	E
Pensacola, Florida	82	71	77	C
Peoria, Illinois	80	53	58	C
Philadelphia, Pennsylvania	73	60	66	E
Phoenix, Arizona	53	30	34	M
Pierre, South Dakota	74	49	43	C
Pittsburgh, Pennsylvania	75	54	60	E
Portland, Maine	75	63	76	E
Portland, Oregon	82	53	45	P
Pueblo, Colorado	68	33	36	M
Raleigh, North Carolina	81	59	72	E
Reading, Pennsylvania	73	54	66	E
Reno, Nevada	57	18	21	P
Richmond, Virginia	79	57	72	E
Rochester, New York	71	53	64	E
Sacramento, California	78	43	34	P
St. Joseph, Missouri	78	51	52	C
St. Louis, Missouri	74	50	56	C
St. Paul, Minnesota	79	55	55	C
Salt Lake City, Utah	46	29	25	M
San Antonio, Texas	85	50	49	C
San Diego, California	88	72	74	P
San Francisco, California	91	69	75	P
Savannah, Georgia	83	63	80	E
Scranton, Pennsylvania	77	58	67	E
Seattle, Washington	85	62	52	P
Shreveport, Louisiana	84	55	62	C
Sioux City, Iowa	79	53	52	C
Spokane, Washington	63	27	24	P
Springfield, Illinois	76	52	57	C
Springfield, Missouri	81	56	61	C
Syracuse, New York	74	59	–	E
Tampa, Florida	82	62	79	E
Toledo, Ohio	74	51	60	E
Trenton, New Jersey	77	57	70	E
Vicksburg, Mississippi	86	60	70	C
Washington, Dist. of Col.	77	57	70	E
Wichita, Kansas	78	50	52	C
Yuma, Arizona	63	27	27	P

Time Zones: E—Eastern; C—Central; M—Mountain; P—Pacific. Central is 1 hr., Mountain 2 hr., and Pacific 3 hr. earlier than Eastern time.

July is the hottest month (over a period of years) these figures give a fairly good idea of normal conditions in midsummer. They give no definite information as to maximum or design conditions.

Since the ability of air to hold moisture increases with its temperature, a high relative humidity in cool regions indicates a higher absolute humidity than the same relative humidity in warm regions. The map, therefore, shows nothing about the absolute humidity.

How the Map is Zoned

The map is divided into zones in order to bring out graphically the extreme conditions encountered. The green zone (over 60% relative humidity) appears only comparatively near the oceans, gulf or lakes, and for that reason is referred to on the map as the Humid Coastal zone. The red zone covers a densely populated section of the eastern half of the country, and since the humidity in this zone is relatively high (50 to 60%) it is designated as the Moist Interior zone.

At the other end of the scale is the very dry region in the far west where the relative humidity is less than 30%, indicated on the map by black cross hatching, and named the Arid Plateau zone. In this region evaporation is high; it is also high in the brown zone (30 to 40%) labeled Dry Slopes zone, and in these two regions the evaporation averages about twice what it does over the rest of the country when measured from April to September. Consequently, it is in these regions, with a July noon humidity less than 40%, that we expect to, and do, find evaporative cooling used. This does not mean that evaporative cooling cannot be used in the other regions, but that these less-than-40% zones are the regions where evaporative cooling finds an obvious use.

The white zone (40-50) is named the Medium Central zone, so that both its color and name indicate a neutral position—neither moist nor dry.

The Table

The table shows these noon relative humidities and, in addition, the morning and evening humidities, for specific cities.

The noon humidities are given at noon local standard times but the 8 a.m. and 8 p.m. readings are 75th meridian time, these being taken simultaneously in all parts of the country for weather-forecast map-making purposes. For this reason, the 8 a.m. and 8 p.m. readings are about 7 a.m. and 7 p.m. readings in the Central time zone, 6 a.m. and 6 p.m. readings in the Mountain time zone, and 5 a.m. and 5 p.m. readings in the Pacific zone. This time difference must be taken into account, since the temperature and consequently relative humidity are changing rapidly at these hours and one, two or three hours can make a sharp difference in results based on the table. Also, since daylight saving is now so widely used, it should also be noted the times are standard.

Water Hammer in Pipe Lines

FROM time to time cases are reported of valves or fittings failing under the stress caused by water hammer. Fittings made of a brittle material are liable to burst under these conditions while fittings made of ductile materials may be so distorted that leakage occurs at threads or joints. To eliminate the possibility of such failures consideration should be given to the shock pressures that may occur in pipe lines carrying liquids. A good explanation of the theory of water hammer and a method of calculating the pressures which may result recently appeared in "The Valve World." This paper was prepared by E. C. Petrie, engineer in charge, design, materials and specifications of the Design and Development Department, Crane Co., Chicago. Abstracts from this paper follow:

Water hammer may be described as a series of pressure pulsations above and below normal, the periodicity of which depends on the size, length, and material of the pipe line. These pulsations result in shock when water or some other relatively incompressible fluid traveling with a certain velocity is stopped in a short period of time. It is, therefore, apparent that shock does not occur in steam or gas lines unless water is carried along with the gaseous fluid.

The increase in pressure due to water hammer is not dependent upon the working pressure of the system but upon the velocity of the liquid. For example, an installation having a working pressure of 100 lb. per sq. in., and operating at a velocity of 3 ft. per sec. will be subjected to the same increase in pressure due to instantaneous closure of a valve as one having a working pressure of 1000 lb. per sq. in. and the same velocity.

When water hammer occurs in a pipe line it usually causes a sound similar to that which is heard when a pipe is struck by a hammer. The intensity of this sound, however, is not a measure of the pressure which is produced above the static pressure, as it has been shown by test that if about 10 or 15% of the shock pressure is removed by a shock absorber installed in the line, the noise is eliminated.

Time of Valve Closure to Cause Maximum Shock

Joukovski, one of the first investigators of the theory of water hammer, published a paper in Moscow, Russia, entitled "Water Hammer" which was reprinted in English in the 1904 Proceedings of the American Water Works Association. Joukovski stated that the maximum increase in pressure in a pipe line would occur when the total flow was stopped in a period of time equal to that required for the pressure wave to travel from the point of closure to the opposite end of the line and return. This time can be stated by

$$t = \frac{2L}{a}$$

where:

- t = time for pressure wave to travel length of pipe and return, sec.
- L = length of pipe line, ft.
- a = velocity of pressure wave, ft. per sec.

The formula which has been developed for the velocity of the pressure wave is

$$a = \frac{12}{\sqrt{\frac{w}{g}\left(\frac{1}{k} + \frac{d}{Ee}\right)}}$$

where:

- g = acceleration due to gravity = 32.2 ft. per sec.^{2}
- w = weight of 1 cu. ft. of water, lb.
- d = inside diameter of pipe, in.
- e = thickness of pipe wall, in.
- k = voluminal modulus of elasticity of water = 300,000 lb. per sq. in.
- E = modulus of elasticity of pipe material, lb. per sq. in.

For *steel* pipe (E = 30,000,000) the equation reduces to

$$a = \frac{4720}{\sqrt{1 + \frac{d}{100e}}}$$

For *cast iron* pipe (E = 15,000,000) the equation reduces to

$$a = \frac{4720}{\sqrt{1 + \frac{d}{50e}}}$$

In order to determine the time required to close valves so that the maximum water hammer will occur in a pipe line, let us assume that an 8-in. steel pipe line (ID = 7.981 in., pipe wall thickness = 0.322 in., length = 1000 ft.) is transporting water at a steady velocity of 3 ft. per sec. The velocity of the pressure wave in pipe of this description, regardless of length, is

$$a = \frac{4720}{\sqrt{1 + \frac{7.981}{100 \times .322}}} = 4225 \text{ ft. per sec.}$$

Therefore, for 1000 ft. of pipe,

$$t = \frac{2 \times 1000}{4225} = 0.47 \text{ sec.}$$

It is apparent that valves must be closed very rapidly to cause maximum water hammer.

Maximum Pressure Caused by Water Hammer

The formula which evaluates the maximum pressure caused by water hammer is

$$P = \frac{aV}{g} \times 0.433$$

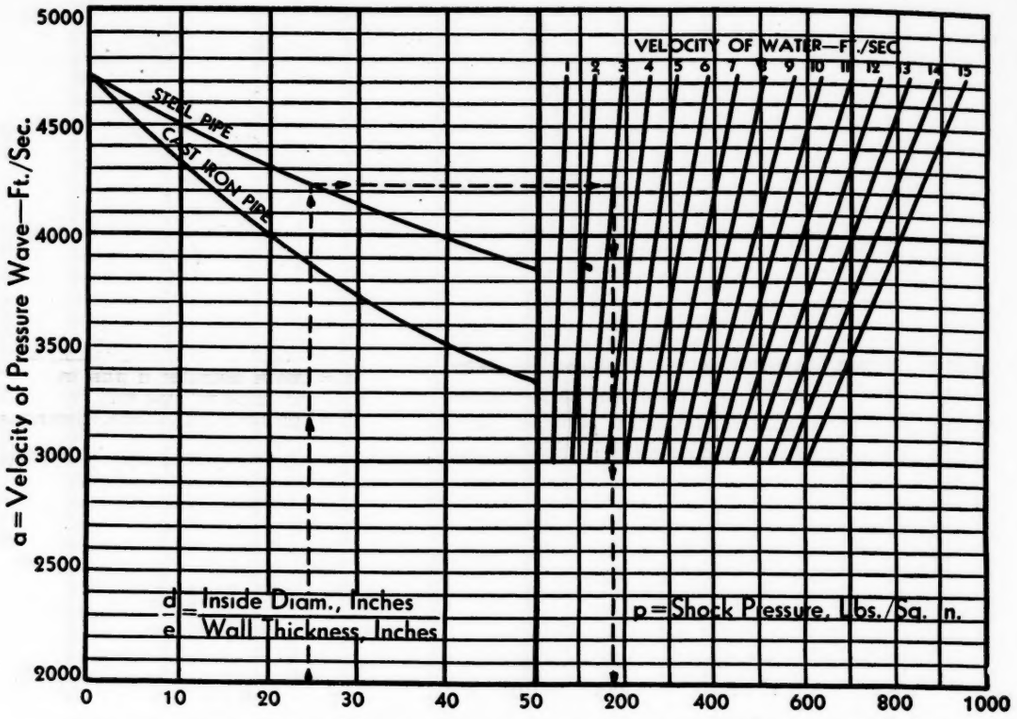
where:

- P = maximum pressure due to water hammer above static pressure, lb. per sq. in.
- a = velocity of pressure wave, ft. per sec.
- V = velocity of water, ft. per sec.
- g = acceleration of gravity, ft. per sec.^{2}

Under the condition stated in the previous example, the maximum pressure above the static pressure in the line will be

$$P = \frac{4225 \times 3}{32.2} \times 0.433 = 170.4 \text{ lb. per sq. in.}$$

The accompanying chart indicates the maximum pressure due to water hammer for various pipe sizes,



Shock pressure caused by water hammer (based on instantaneous closure of valves).

EXAMPLE: What is the maximum shock pressure caused by water hammer in an 8-in. steel pipe line (0.322 in. wall thickness) transporting water at a steady velocity of 3 ft. per sec.?

PROCEDURE: Determine the ratio $\frac{d}{e}$. This value is $\frac{7.981}{0.322} = 24.8$

Enter chart at $\frac{d}{e} = 24.8$ and project upward to intersection with line for steel pipe.

Note that value of "a" = 4225 ft. per sec.

Project horizontally to the right to intersection with 3 ft. velocity line and then down to base line where shock pressure of 170 lb. per sq. in. is obtained.

thicknesses, and velocities of water. Curves are given for the velocity of the pressure wave for steel and cast iron pipe.

NOTE: While the formulas previously given have been based upon tests conducted with water, it is logical to assume that shock pressures caused by another incompressible fluid can be ascertained by the proper substitution in the formula of the physical constants of this fluid, namely, weight per cubic foot and modulus of elasticity.

General Recommendations for Shock Service

1. When using valves and fittings in lines where shock is likely to occur, the maximum increase in pressure due to shock should be added to the static pressure in determining the safety factor for the valve or fitting.

2. It must be remembered that brittle materials such as cast iron, etc., are subjected to fatigue, and, therefore, the factor of safety over the maximum pressure which may be obtained should be enough to prevent failure.

3. The use of the proper size of hydraulic shock absorber or other means of eliminating shock is strongly recommended. The use of this equipment, as a general rule, does not eliminate shock entirely, but reduces the shock sufficiently to remove the clanking sound.

It is suggested that, where shock absorbers are installed in a pipe line to eliminate the noise due to water hammer, without due consideration being given to the actual reduction of the excess pressure due to shock, 85% of the maximum pressure which is caused by water hammer under the transportation conditions be added to the static pressure in the line to serve as a basis for safe design of the equipment.

4. Shock absorbers should be placed as close as possible to the source of the water hammer.

5. The Code for Pressure Piping, ASA B31.1—1935, recommends in Section I, paragraph 122(d) that "In the case of cast iron pipe the minimum values of the water-hammer allowance to be added to P (static pressure) are given in Table 4." This table follows:

WATER-HAMMER ALLOWANCE FOR CAST IRON PIPE (ASA Code for Pressure Piping)

Pipe Diameter, In. (Sizes, Inclusive)	Minimum Water-Hammer Allowance Lbs. per Sq. In.
4 to 10	120
12 to 18	110
20	100
24 to 30	95
36 to 48	90
54 to 84	85

Dehumidification for Factory Processing

GENERALLY speaking, dehumidification is the process of removing moisture from the air. This dry air is in turn used in dehydrating or removing water from various materials. Drying is the simple term commonly employed for both. Dehumidifiers or air drying machines are being increasingly used in industry and are applicable to practically any problem involving the use of dry air. These machines or units operate independently of the temperature, and automatically maintain any degree of humidity regardless of changes in temperature.

This characteristic extends this method of drying to those products which may be damaged physically or changed chemically, if heat is applied. Such hygroscopic materials as paper, film, textiles, foodstuffs, tobacco, chemicals and drugs come under this classification.

One process that practically all manufacturers have to contend with is the finishing of their products. The drying of these finishes usually constitutes a serious bottle neck. Drying ovens have solved the problem of quick drying for some. Others have resorted to controlled dehumidification. The Forsberg Manufacturing Co., Bridgeport, Conn., maker of hack saws, saw frames and screw drivers, finishes these items with a fast-drying lacquer. In spite of the high quality of lacquer, drying under high humidity conditions was a most troublesome factor. In fact there were long periods of time when the humidity was so high that no drying could be done at all. In addition the plant is located on a large body of water which aggravates this situation.

A gas dehumidification unit was installed which removes most of the moisture from the air which is then forced into the finishing room. The room is 18x35x10 ft. high (6300 cu. ft.) and the unit delivers 600 cu. ft. of conditioned air to it per minute. An all-year-round system, cold water coils in the outlet duct, keep the air cool in summer, while steam coils warm it in the winter.

The conditioned air is forced into the room at a point close to the ceiling and after circulating and taking up the moisture and lacquer fumes, it is collected in perforated pipes. These are connected to an exhaust fan and are laid along the floor close to the walls. With this system a uniform drying period is now established throughout the year which is from 25 to 50% faster than previously under the best circumstances. Experience here and elsewhere indicates that most lacquers dry satisfactorily with a relative humidity of 40% or lower. The temperature is not important.

Foundrymen have noticed that changing weather, together with varying percentages of humidity in the air introduced into the cupola, so altered the characteristics of the resulting iron as to cause considerable annoyance. In an attempt to correct this situation in one foundry a dehumidification unit has just been installed. This unit is designed to maintain the moisture of the air at a constant percentage throughout the year.

Many concerns have turned in recent years to plastics as a material for their products, in whole or in part. The materials from which plastics for molding are made are hygroscopic so it is necessary to manufacture them in a dehumidified atmosphere for about three quarters of the year. A relative humidity of 20% and a dry bulb temperature of 85F are satisfactory for this class of work. Furthermore, some of these plastics collect moisture after manufacture which is of no consequence in many applications. In the molding of condenser cases, however, the moisture must first be driven out, as humidity will ruin condensers. The Solar Mfg. Co., maker of condensers for radios, uses a gas unit in its Bayonne, N. J., plant to furnish dry air both to the molding room and the room in which the condensers are made.

In one method of making tungsten wire, the powdered tungsten is mixed with a binder and molded into sticks prior to the application of the heat. This binder is hygroscopic and to prevent it from picking up moisture from the air it is stored in an air conditioned space. A dehumidifying unit is employed to dry the air.

The sensitizing, exposing and developing of zinc plates are made possible with controlled relative humidity. Air conditioning is furnished to two rooms in the Long Island plant of the Latham Litho Co., New York. The plates are sensitized with ammonium dichromated gum in the first room and they are exposed and developed in the second. This process is extremely difficult if not impossible without dehumidification. Many of these lithograph plates are of considerable value and must also be stored in a dry place.

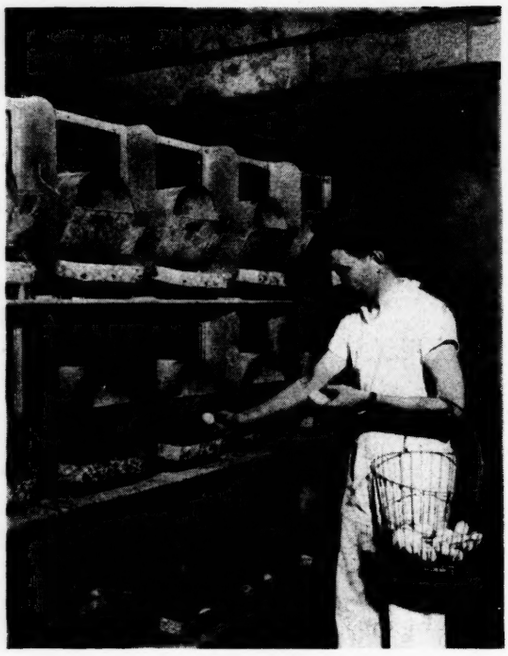
A dehumidifying unit is used in this plant to dry the plastic used in molding condenser cases.

In order to be independent of weather conditions in the drying of shoes, the J. Edwards Co., Philadelphia, maker of children's shoes, uses a gas dehumidifier. This unit furnishes dry air for seven shoe operations and extracts moisture, thus speeding the drying of shoes after each of the different staining and bleaching processes. Formerly simple air drying was employed and high humidity frequently held up plant operations and production schedules. — *J. B. Nealey, American Gas Association.*

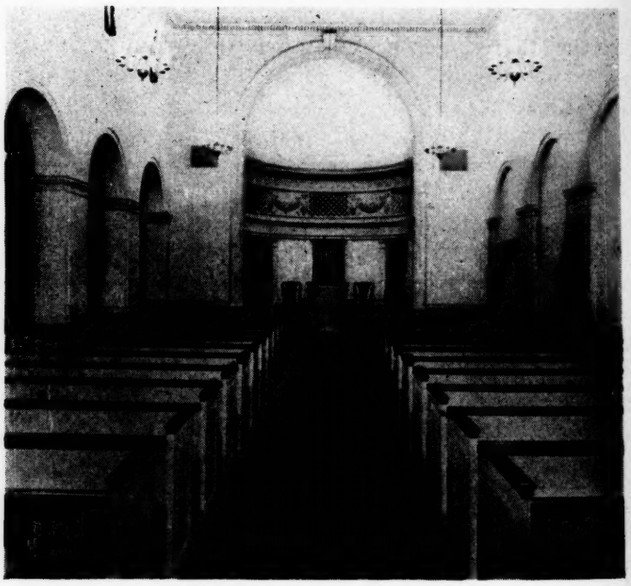
WAFFLE WEAVE material is employed in the new automatic electric blanket shown at left in a crib type model complete with drawstrings. Photo courtesy General Electric.

FILTER TESTS under way by R. S. Dill at the National Bureau of Standards. Artificially dusted air is drawn through different type units to obtain the comparative data. Harris & Ewing photo.

PICTURE



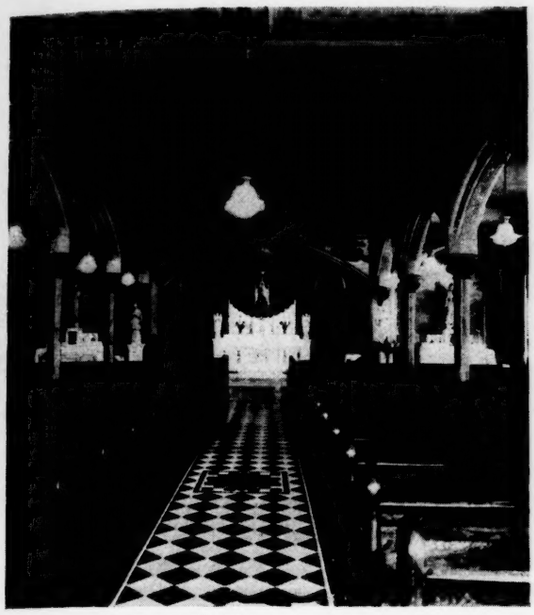
CONDITIONED HEN HOUSE at the Department of Agriculture experimental farm at Beltsville, Md. The ducts are shown on the ceiling. The view shows R. B. Nestler, poultry expert, removing the eggs. Harris & Ewing photo.



TRAVEL IN THE OZARKS will be more comfortable in this new streamlined air conditioned gas-driven motor car, built by ACF, one of two which will run between Joplin, Mo., and Helena, Ark. A 5½-ton cooling plant and a coal-fired hot water heater maintain comfortable conditions.

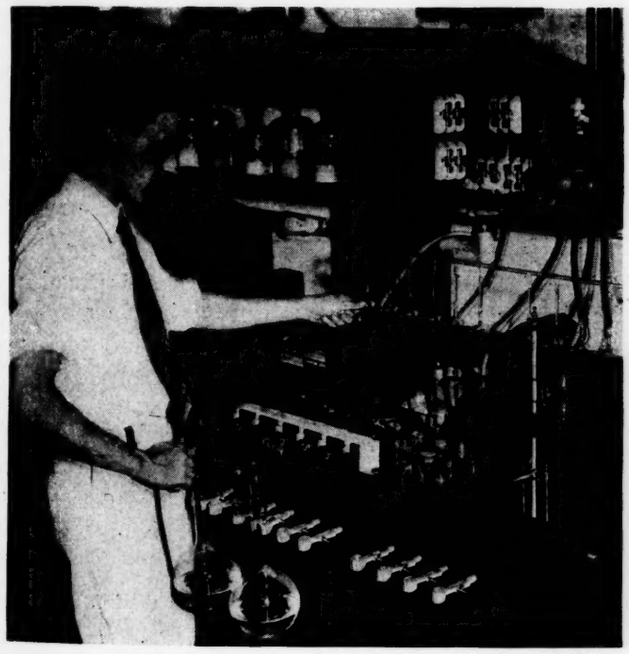
$150,000 AIR CONDITIONED MORTUARY of John M. Oakey, Inc., in Roanoke, Va., cooled by 7½-ton GE compressor supplemented by well water from a 400-ft. well. Smithey and Boynton designed the system and Richardson-Wayland Corporation installed the plant.

AIR CONDITIONED CHAPEL at St. Louis University cooled by eight portable conditioners, six of which are shown along the wall (right). The chapel which is 50 x 65 ft. (below) seats 200. Installation was made by Artophone Corp., Philco Radio and Television Corporation distributor for St. Louis.



PARAGRAPHS

MISS BRIDGEPORT (Dorothy Parker) checks the temperature on an American dial thermometer before a plunge.



ACIDITY STANDARDS for water will result from the electrometric measurements being made by Dr. W. J. Hamer at the National Bureau of Standards. These data will be useful in the analysis of water for air conditioning.

PROTECTED FROM THE SIROCCOS which blow in from the deserts these babies in the Maison d'Accueil foundling institution in Tunis, Africa, are kept comfortable and healthy by cooled air from a Kelvinator conditioner.

Fig. 1. Blower type unit heater in ceiling of garage

Carbon Monoxide in Public Garage Ventilation†

THE public garage or service station presents a special problem in ventilation: that of adequately disposing of the exhaust gas which is being constantly generated by running engines. The extent of the problem can only be appreciated when one considers that cars in the process of repair are being constantly started and stopped and that in the course of the testing process the air-gasoline ratio in the carburetor may at times be very low. The exhaust gas from a car which is being run under these conditions has a far larger percentage of carbon monoxide than has the exhaust from a car which is being normally operated.

The exhaust gas is usually discharged at the rear of the car about 15 in. above the ground. Its density is practically that of air (9.9678) and it is only its warmth which tends to make it gradually rise to the ceiling. Tests made by the Division of Industrial Hygiene at a distance of two feet back of cars which were actively exhausting showed the concentration of carbon monoxide in the air to be 7 to 11 parts per 10,000 parts of air. In view of the fact that for purposes of safety the carbon monoxide content of the air should never exceed one part per 10,000 for continuous exposure, it will readily be seen how dangerous this condition may become — particularly in small and ill-ventilated garages. To the worker lying under such a car for the purpose of making repairs it is extremely hazardous.

Moreover, unfavorable atmospheric conditions may seriously aggravate the situation. During warm weather, for example, a unit weight of air occupies a considerably greater volume than when the weather is cold, with the result that the same carburetor adjustment sucks in a smaller amount of oxygen and the percentage of carbon monoxide in the exhaust gas is, in consequence, correspondingly higher. The fact that the windows and doors of the workroom are apt to be open during this period of the year tends to offset this to some extent but not entirely. On a damp cold day, however, when there is little air movement and the windows are closed a most hazardous situation is presented from the standpoint of exposure to carbon monoxide gas.

The principal factors determining the concentration of carbon monoxide gas in a given workroom may be briefly summarized as follows:

1—The cubic contents of the room.
2—The number of automobiles in operation.
3—The size of the automobiles—since cars vary materially in their output of carbon monoxide according to size and type of motor.
4—The amount of air movement in the room.
5—The temperature.
6—The humidity.
7—The amount of natural ventilation as provided by windows, doors, or skylights.
8—Devices available for immediate removal of exhaust gases.
9—Provisions for general artificial ventilation.

The special problems of ventilation peculiar to service stations arise primarily from the fact that the carbon monoxide content of the air in the room as a whole

†From Special Bulletin No. 194, 1938, New York State Department of Labor, by May R. Mayers, M.D., "Carbon Monoxide Poisoning in Industry and its Prevention."

is not usually an adequate criterion of exposure. Tests made near engines which are discharging exhaust gas show a far greater concentration of carbon monoxide than is to be found in the room as a whole. Consequently, a man working on a particular car may be exposed to almost undiluted exhaust gas for a brief time. Sometimes the exhaust is discharged right into his face. In other words, the carbon monoxide content of the air in a service station varies from place to place and from time to time during the day. The exposure of a given worker could, therefore, only be accurately determined by following him about all day long, taking repeated samples of air at each place where he works and while he is actually there. It has been our experience that even in rooms where no excessive carbon monoxide content could be demonstrated in the air of the workroom as a whole, individual workmen have been exposed to high concentrations of the gas at various times in the course of the day. Safety requirements, therefore, demand not merely that the concentration of carbon monoxide gas should not exceed one part per 10,000 for the room as a whole, but that each worker be protected from exposure to the much higher concentrations to which he is exposed when he works at, or very near, the point where the exhaust gas is being given off by his car.

For cars which are being tested while at rest a device which has been installed in a number of service stations in the State of New York in the last few years has been of tremendous value not only in reducing the carbon monoxide content of the workroom as a whole, but in protecting workers doing repairs in the immediate vicinity of the exhaust. Since by far the largest number of cars are tested while at rest, this has contributed materially to safeguarding the health of garage workers in recent years. Briefly, the device is as follows:

The exhaust pipe of the car which is to be tested is connected by means of some flexible tubing to a large metal stationary pipe which runs around the room. This in turn is provided with an exhxaust fan. By this simple means the fumes from the exhaust pipe of the car are carried directly out of doors without ever getting into the air of the room at all. The introduction of this method of removing exhaust gas at its source constitutes perhaps the most valuable simple improvement in the ventilation of service stations in recent years.

Important as this ventilating device is, however, it is not without its limitations since it is quite inapplicable to cars which are running in and out of service stations or to those which are run around the floor of the workroom while they are being tested. It is necessary, therefore, to consider means for removing as directly and as rapidly as possible the exhaust gas given off by cars in motion, so that pollution of the air at the working level may be reduced to a minimum. This brings up the question of a vertical exhaust suggested sometime ago by Henderson.

It was his suggestion that every car be constructed with a vertical exhaust pipe analogous to a chimney rising to a point just above the roof of the car. In this way, carbon monoxide would be discharged upward, and so above the breathing level of persons in the streets, instead of downward as at the present time. The application of this principle to enclosed spaces, such as garages, with a view to facilitating the speedy removal of any carbon monoxide which is generated therein immediately suggests itself. If provision were made for the exhaust gas from moving cars to be discharged well above the heads of the workers and thence carried into the open air by means of upward ceiling exhaust ventilation it could be removed so rapidly that there would be very little opportunity for its dissemination into the air of the room as a whole. The atmosphere of the room at the breathing level of workers could thus be made virtually free from carbon monoxide gas.

To this end it would be necessary (since cars are not built with vertical exhaust pipes at the present time) to have available in service stations a number of detachable vertical pipes which could be readily clamped on to any car before it is driven about in the workroom. It could subsequently be removed. It may be argued that such a device would be regarded as a nuisance and that workers would neglect to use it. Undoubtedly it would be something of a nuisance. Its use might, indeed, be entirely dispensed with if sufficient provision were made for plenum-exhaust ventilation for the room as a whole. But this latter is frequently so expensive as to be prohibitive. The detachable vertical exhaust

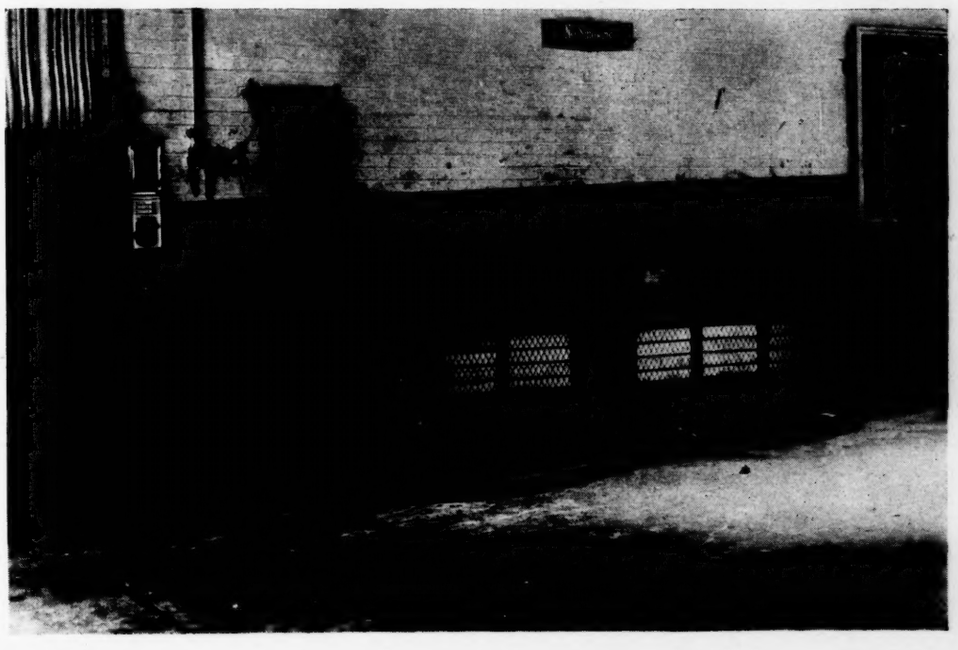


Fig. 2. Exhaust louvers in the sidewalls exhaust air at the floor level. View is of the same garage shown in Fig. 1 where entire workroom is ventilated as a whole.

Fig. 3. Ventilation to dispose of motor combustion gases direct from automobile exhaust pipe. Note that with this method plan is to prevent carbon monoxide from reaching the general air of the workroom.

pipe offers an economical solution of this very difficult ventilating problem and may therefore be well worth the extra trouble which its use would entail. In the last analysis, the method to be adopted must of course be a matter upon which each service station would have to make an independent decision in the light of its own special conditions and experience.

There are thus two distinct problems of ventilation: (1) To remove promptly the exhaust gas from cars which are at rest (but whose engines are being operated) and carry it directly out of doors, so that it may never get into the air of the workroom at all; and (2) to remove as expeditiously as possible exhaust gas discharged into the workroom by cars in motion. This may be accomplished without excessive cost, along the lines above indicated. In any special cases where these means prove inadequate air conditioning for the workroom as a whole must be considered.

Protection of Persons Indirectly Exposed to Carbon Monoxide

In considering the reduction of the carbon monoxide hazard in service stations attention should be directed to the construction of buildings so as to prevent exhaust gases from being disseminated from one floor to another thereby exposing to carbon monoxide gas, office workers and others who are in no way directly connected with the operation of the cars in the repair shop.

Informational Poster for Garages

It is suggested that a poster containing such information as the following be displayed in all public garages and service stations for the guidance of workers:

The exhaust gas given off by automobiles contains very large amounts of carbon monoxide gas. It may be as high as 10-12%.

Breathing air containing carbon monoxide may cause injury to your health. Have a physical examination every 3 months.

You cannot know whether or not carbon monoxide gas is present in the air of your workroom in dangerous amounts because it is a colorless, odorless, and tasteless gas. It does not cause any irritation on your nose or throat. Only chemical analysis of the air can disclose its presence.

When you are repairing or testing cars use every available device for removing the exhaust gas at its source. Try to avoid getting any of it into the room insofar as this is possible.

If you are not feeling well—particularly if you are subject to headaches—report this at once to your doctor or your employer. It may be that the general ventilation of your workroom as a whole needs improvement.

Workers who are nervous, or who have heart trouble or anemia should not work in garages or elsewhere where there may be exposure to carbon monoxide gas.

Effect of Reactivity and Caking When Burning Coal

THE relative rates of burning of coals when all other conditions, such as size of the pieces, depth of bed, rate of flow of air through the bed, and the furnace, are the same, depend mainly on the effect of the caking of the coal on the distribution of the air and on the relative area of coal the air can contact. The rate of burning of the coke which is formed from the coal in the fuel bed depends on the size of the pieces of coke and on their reactivities, that is, relative ability of the carbon of the coke to unite with oxygen, carbon dioxide, and water vapor. These facts were emphasized recently by P. Nicholls, heat transmission engineer, Bureau of Mines, in presenting the results of some experimental studies of fuel beds before the Fuel Engineering Division of Appalachian Coals, Inc., at Cincinnati.

Measurements of reactivities usually have been associated with manufactured cokes, and little is known about the reactivities of cokes formed in fuel beds. However, these studies showed that although values for reactivity of cokes vary largely at temperatures below 2000F, differences between these values decrease as the temperature increases and will be negligible at the temperatures which exist in industrial fuel beds. On the other hand, decrease in the size of the pieces of coke increases the rate of gasification independently of temperature and, therefore, the size of the pieces materially affects the rate of burning of fuel beds which are similar in all other respects, including the rate of flow of air through them.

Caking affected both the initial resistances of the fuel beds and the average rate of burning. The maximum drop in pressure for the same air flow through the bed for the most strongly caking coal was as much as 15 times that of the most weakly caking; the average rate of burning of the strongly caking coals was lower by as much as 100%. These tests are for an undisturbed bed and the effects of caking can be counteracted by agitation of the bed. The results do not mean that high rates of burning cannot be obtained with strongly caking coals, or that caking has not offsetting advantages. They do show that more knowledge is required on the effect of caking in fuel beds, both for the design of equipment and in the selection of coal for existing plants.

REFRIGERANTS FOR AIR CONDITIONING—CARBON DIOXIDE

PROPERTIES OF SATURATED CARBON DIOXIDE

Deg. F	Pressure		Volume		Heat Content		Entropy	
	Lb. per Sq. In.		Cu. Ft. per Lb.		B.t.u. per Lb. Above —40F		Liquid	Total of Vapor
	Abs.	Gauge	Liquid	Vapor	Liquid	Total of Vapor		
1	2	3	4	5	6	7	8	9
0	305.5	290.8	0.01570	0.29040	18.8	138.9	0.0418	0.3024
2	315.9	301.2	0.01579	0.28030	19.8	138.8	0.0440	0.3014
4	326.5	311.8	0.01588	0.27070	20.8	138.8	0.0461	0.3005
6	337.4	322.7	0.01596	0.26140	21.8	138.7	0.0483	0.2994
8	348.7	334.0	0.01605	0.25260	22.9	138.7	0.0504	0.2982
10	360.2	345.5	0.01614	0.24370	24.0	138.7	0.0526	0.2970
12	371.9	357.2	0.01623	0.23540	25.0	138.6	0.0548	0.2958
14	383.9	369.2	0.01632	0.22740	26.1	138.6	0.0571	0.2946
16	396.2	381.5	0.01642	0.21970	27.2	138.5	0.0593	0.2933
18	408.9	394.2	0.01653	0.21210	28.3	138.4	0.0616	0.2921
20	421.8	407.1	0.01663	0.20490	29.4	138.3	0.0638	0.2909
22	434.0	419.3	0.01673	0.19790	30.5	138.2	0.0662	0.2897
24	448.4	433.7	0.01684	0.19120	31.7	138.1	0.0686	0.2885
26	462.2	447.5	0.01695	0.18460	32.9	138.0	0.0710	0.2873
28	476.3	461.6	0.01707	0.17830	34.1	137.9	0.0734	0.2861
30	490.8	476.1	0.01719	0.17220	35.4	137.8	0.0758	0.2849
32	505.5	490.8	0.01731	0.16630	36.7	137.7	0.0781	0.2834
34	522.6	507.9	0.01744	0.16030	37.9	137.4	0.0804	0.2820
36	536.0	521.3	0.01759	0.15500	39.1	137.2	0.0828	0.2805
38	551.7	537.0	0.01773	0.14960	40.4	136.9	0.0851	0.2791
40	559.7	545.0	0.01780	0.14700	41.0	136.8	0.0861	0.2783
40	567.8	553.1	0.01787	0.14440	41.7	136.7	0.0874	0.2776
41	576.0	561.3	0.01794	0.14185	42.3	136.5	0.0887	0.2768
42	584.3	569.6	0.01801	0.13930	42.9	136.3	0.0899	0.2761
44	601.1	586.4	0.01817	0.13440	44.3	136.1	0.0924	0.2745
46	618.2	603.5	0.01834	0.12970	45.6	135.7	0.0950	0.2730
48	635.7	621.0	0.01851	0.12500	47.0	135.4	0.0975	0.2714
50	653.6	638.9	0.01868	0.12050	48.4	135.0	0.1000	0.2699
52	671.9	657.2	0.01887	0.11610	49.8	134.5	0.1027	0.2681
54	690.6	675.9	0.01906	0.11170	51.2	133.9	0.1054	0.2663
56	709.5	694.8	0.01927	0.10750	52.6	133.4	0.1081	0.2644
58	728.8	714.1	0.01948	0.10340	54.0	132.7	0.1108	0.2626
60	748.6	733.9	0.01970	0.09940	55.5	132.1	0.1135	0.2608
62	769.0	754.3	0.01995	0.09545	57.0	131.3	0.1164	0.2584
64	789.4	774.7	0.02020	0.09180	58.6	130.6	0.1194	0.2560
66	810.3	795.6	0.02048	0.08800	60.2	129.7	0.1223	0.2535
68	831.6	816.9	0.02079	0.08432	61.9	128.7	0.1253	0.2511
70	853.4	838.7	0.02112	0.08040	63.7	127.5	0.1282	0.2487
72	875.8	861.1	0.02151	0.07654	65.5	126.0	0.1321	0.2450
74	898.2	883.5	0.02192	0.07269	67.3	124.5	0.1360	0.2414
76	921.3	906.6	0.02242	0.06875	69.4	122.8	0.1398	0.2377
78	944.8	930.1	0.02300	0.06473	71.6	120.9	0.1437	0.2341
80	968.7	954.0	0.02370	0.06064	73.9	118.7	0.1476	0.2304
82	993.0	978.3	0.02456	0.05648	76.4	116.6	0.1578	0.2195
84	1017.7	1003.0	0.02553	0.05223	79.4	113.9	0.1679	0.2087
86	1043.0	1028.3	0.02686	0.04789	82.3	110.4	0.1781	0.1978
87.8	1069.9	1055.2	0.03454	0.03454	97.0	97.0	0.1880	0.1880

PROPERTIES OF SUPERHEATED CARBON DIOXIDE VAPOR

Saturated Vapor		Superheated Vapor					
		Volume Cu. Ft. per Lb.	Heat B.t.u. per Lb.	Entropy B.t.u. per Lb.	Volume Cu. Ft. per Lb.	Heat B.t.u. per Lb.	Entropy B.t.u. per Lb.
Temp.	Press.	10F of Superheat			30F of Superheat		
1	2	3	4	5	6	7	8
0	305.5	0.34	144.9	0.322	0.37	152.7	0.334
10	360.2	0.29	145.9	0.311	0.32	153.3	0.326
20	421.8	0.22	145.4	0.301	0.25	153.8	0.318
30	490.8	0.19	144.7	0.295	0.21	154.3	0.314
40	567.8	0.16	144.1	0.289	0.19	154.2	0.313
50	653.6	0.14	144.4	0.287	0.17	155.0	0.312
		70F of Superheat			100F of Superheat		
0	305.5	0.39	157.9	0.345	0.42	165.7	0.362
10	360.2	0.34	158.7	0.336	0.37	166.8	0.351
20	421.8	0.28	159.3	0.329	0.30	167.5	0.345
30	490.8	0.23	160.1	0.327	0.26	168.7	0.342
40	567.8	0.21	160.8	0.326	0.24	169.5	0.342
50	653.6	0.19	161.4	0.324	0.22	170.2	0.339

Heat Content and Entropy are above minus 40F

CARBON DIOXIDE (CO_2)

Boiling Point, minus 109.3F Freezing Point, minus 69.9F	Critical Temperature, 88F Critical Pressure, 1069.9 lb. per sq. in.

Approximate Specific Heats (Over Range of Tables)

Liquid, from 0.53 to 1.02; Vapor at constant pressure = C_p = 0.206; and Vapor at constant volume = C_v = 0.163, for C_p/C_v = 1.28

Properties at Common Rating Points

(Without Liquid Sub-Cooling and Without Superheat in Suction, Dry Compression)	Refrig.	Air Cond.
	at 5F Suction	at 40F Suction
	And 86F Condenser Temperature	
Cooling coil (low side) pressure, (lb., abs)	332.0	567.8
Condenser (high side) pressure, (lb., abs)	1043.0	1043.0
Heat in suction vapor, B.t.u. per lb., (column 7)	138.8	136.7
Heat in liquid before exp. valve, per lb., (column 6 at 86F)	83.3	83.3
Refrigerating effect,[1] (B.t.u. per lb. of refrigerant)	55.5	53.4
Theoretical work of compression,[2] (B.t.u. per lb.)	25.7	14.0
Volume of suction vapor, cu. ft. per lb., (column 5)	0.2661	0.1444
Theor. lb. of refrigerant, per ton, per min.[3]	3.6	3.75
Theor. piston displ., per ton, per min., (cu. ft.)[4]	0.958	0.540
Horsepower per ton[5]	2.18	1.24
Coefficient of performance, cycle[6]	2.16	3.82
Coefficient of performance, carnot	8.74	10.37

[1]Equals difference between two preceding figures.
[2]By computation, from equating entropies.
[3]Equals 200 ÷ refrigerating effect.
[4]Product of two preceding figures.
[5]By calculation.

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REFRIGERANTS FOR AIR CONDITIONING—CARBON DIOXIDE

The data in the several tables of this sheet present in a compact form the commonly desired properties of the refrigerant carbon dioxide. Values as tabulated are based on what are usually considered reliable studies and believed to be the best available. The properties have been extensively investigated and appear to be well established.

It should be noted that the specific heats of carbon dioxide are variables in the range of the tables. The values listed should be considered those at about the middle of the tables. In the case of the specific heat of the liquid the range is noted. An idea of the range of the specific heat at constant pressure can be obtained from the tables on superheated and saturated vapor. The ratio of C_p to C_v is also not strictly constant at 1.28 but this value is the one listed since it is the one most frequently stated for CO_2.

The saturated table extends over the usual range for air conditioning and much commercial refrigeration work. Both gage and absolute pressure are listed for convenience, with the atmospheric pressure considered steady at 14.7 lb. per sq. in. Volumes of both liquid and vapor are given instead of densities, but the density can be found as the reciprocal of the unit volume when this figure is needed. Entropies are included because of their usefulness in analyzing possible performances.

The superheat table is purposely limited to superheats in the region of the temperature and pressure of the suction vapor, and at the temperatures commonly associated with air conditioning and commercial refrigeration work.

Superheat properties over the whole range require more space for tabulation than the frequency of their use seems to justify here.

The various properties tabulated at the common rating points for air conditioning and refrigeration purposes are especially valuable when comparing the characteristics of refrigerants. Many of these figures are also applicable for estimating purposes.

The table giving suitable pipe sizes for use with carbon dioxide when the cooling load is known, is believed to be amply safe for most air conditioning and refrigeration purposes since the sizes are based on small velocities and low unit pressure drops in the piping.

PIPE SIZES FOR CARBON DIOXIDE

Nominal Pipe Size In Inches	Vapor Suction Lines		Liquid Lines	
	Cooling Load In B.t.u. per Hour			Lb. of CO_2 per 100 Lin. Ft.
	Refrig. (5F)[1]	Air Cond. (40F)[2]		
⅛				
¼				
⅜				
½	18,000	24,000	240,000	5
¾	36,000	48,000	600,000	12
1	60,000	84,000	900,000	21
1¼	96,000	132,000	1,320,000	32
1½	144,000	180,000	1,920,000	46
2	240,000	324,000	3,600,000	82
2½	360,000	480,000	5,160,000	128
3	540,000	720,000		
3½	720,000	984,000		
4	960,000	1,272,000		
5	1,440,000	1,920,000		
6	2,160,000	2,880,000		
Max. Velocity f.p.m.	900	700	225	
1	2	3	4	5

[1] If suction temp. is under 25F use column headed (5F).
[2] If suction temp. is over 25F use column headed (40F).

NOTE:—Lines ⅜ in. and Less:—Under 25 lin. ft., as tabulated; 26 to 75 lin. ft. use one size larger; 76 to 150 lin. ft. use two sizes larger.
Lines 1 in. to 2 in., Inclusive:—Under 50 lin. ft., as tabulated; 51 to 100 lin. ft. use one size larger; 101 to 200 lin. ft. use two sizes larger.
Lines 2½ in. and Over:—Under 100 lin. ft., as tabulated; 101 to 200 lin. ft. use one size larger; 201 to 800 lin. ft. use two sizes larger.

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INDUSTRIAL EXHAUST VENTILATION

Structural Details and System Planning

By JOHN L. ALDEN

MOST blowpiping is rolled from galvanized sheet steel, riveted or spot welded and soldered. The length of each section or "joint" usually is made equal to the width of the sheet adopted as the shop standard. For example, a common sheet size is 36 in. by 96 in. which will make pipe in 36-in. lengths and up to 30-in. diameter with a single longitudinal seam. In order that piping may be lapped in the direction of air flow, each section is tapered slightly. The small end is made equal to the nominal pipe size and the large end is made ¼ in. greater in circumference. The corner of the longitudinal lap is clipped at the small end of the section as in Fig. 90a so that only one thickness of metal need be forced into the next section. The preferred lengths of laps are given in Table 22 and the circumferential rivet spacing in Table 23.

In Table 22 is also listed the recommended thickness of metal for various classes of service. While reasonable life may be expected of piping made to these specifications, no accurate prediction is possible. Nevertheless, barring accidents, a well built woodworking system should last from 10 to 15 years and one handling granite dust from 2 to 5 years. The elbows of a conveying system handling heavy tonnage of abrasive materials will cut through in 12 months or so while the piping will last about twice as long.

Wooden ducts and hoods are effective protection against many corrosive fumes. Steel pipes may be coated with rubberized paint to withstand chlorine or hydrochloric acid fumes. Asphaltum paint has been used successfully against sulphuric acid vapor. Many special alloys, all somewhat costly, have been developed to resist chemical attack. Sometimes as effective surface protection can be obtained from sprayed coatings of molten alloy as from solid sheets.

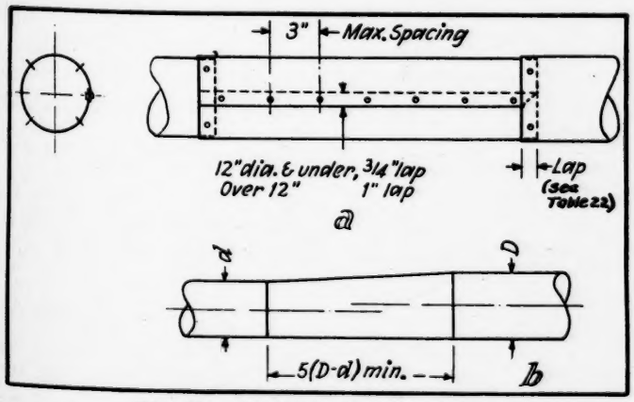

Fig. 90. Straight pipe and tapers.

TABLE 22—RECOMMENDED THICKNESS OF SHEET METAL AND LENGTH OF LAP

Pipe Diameter, In.	Thickness, U.S.S. Gage			Lap, In.
	Ordinary Service*	Severe Service**	Abrasive Conveying***	
8 and under	24	22	16	¾
9 to 16	22	20	14	1
17 to 24	20	18	12	1¼
25 to 30	18	16	—	1½
31 to 42	16	14	—	1¾
43 and over	14	—	—	2

*Woodworking, buffing, textile and other non-abrasive solids in dust-collecting quantities.
**Sandblast, grinding, foundry dust and other abrasive solids in dust collecting quantities. Heavy enough for any exhaust purpose.
***Conveying sand, ashes, cement and other abrasive solids at high velocities and in large quantities.

Tapers

Fig. 90b shows the minimum permissible length of tapers. It is preferable to make tapers equal in length to the sheet width as has been recommended for pipe. The eccentric taper whose bottom lies in the same plane as the bottom of the pipe is thought to be a little less susceptible to clogging than a plain conical concentric taper. When the expansion angle is small, there is probably little difference in performance.

Branches should enter tapers from the top or sides rather than the bottom to prevent idle branches from filling with refuse. Tees entering the main from opposite sides should be staggered to minimize interference of opposing streams.

Gages of metal, length of laps and rivet spacing should be the same as for straight pipe of the same diameter as the large end of the taper.

Elbows

Two-piece or mitre elbows should not be used in exhaust work. Five-piece construction is satisfactory for elbows 6 in. in diameter or smaller and 7-piece for larger sizes. A single pattern for a 90° elbow of a given diameter and throat radius will make elbows of

TABLE 23—RIVET OR SPOT WELD SPACING FOR CIRCUMFERENTIAL SEAMS

Pipe Diameter, In.	No. Rivets
8 and under	4
9 to 12	5
13 to 18	6
19 to 24	7
25 and over	9 in. centers

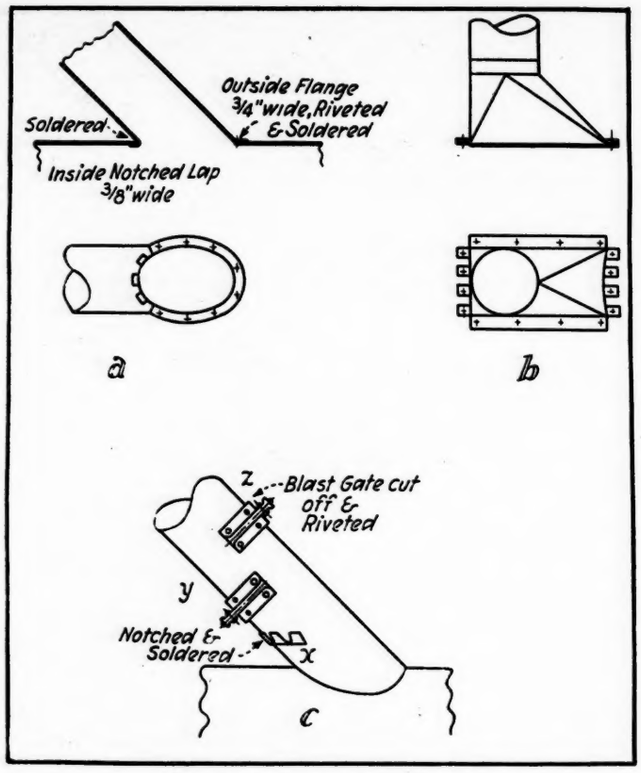

Fig. 91. Tees and equalizers.

other angles. Thus, a 5-piece pattern will make 22½°, 45° and 67½° elbows and a 7-piece will make 15°, 30°, 45°, 60° and 75° elbows. Elbows should be made from metal at least two gages heavier than the pipes to which they connect.

Tees

Fig. 91a shows the usual 45° round tee. While smaller angles of junction are preferable, the tees become structurally weak. It will be seen from the cut that the notched flange at the heel of the tee is already inaccessible for riveting and is difficult to reach with a soldering copper. The "shoe" tee, Fig. 91b, escapes this weakness. No data are available as to the relative pressure losses of the two types but there is no evidence that the pressure drop through the shoe tee is excessive.

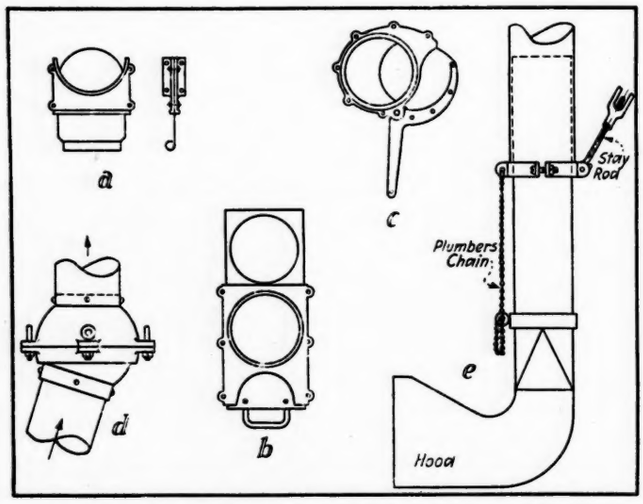

Fig. 92. Blast gates, ball joints and telescope joints.

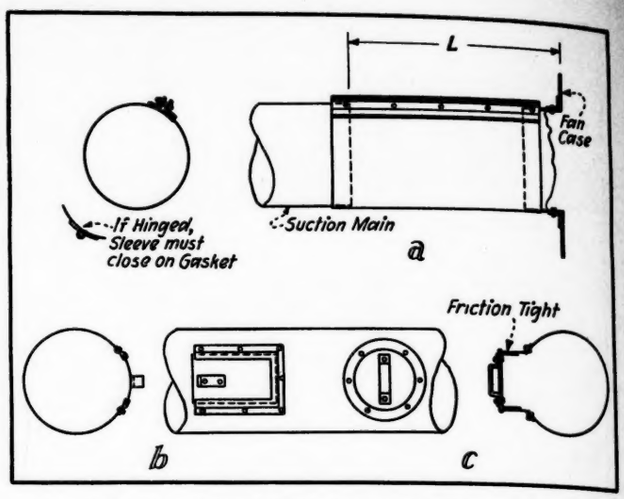

Fig. 93. Pipe sleeve and hand hole covers.

Equalizers

Equalizers are fixed dampers for regulating the distribution of air between branches. The style x, Fig. 91c, consists of a sheet of heavy steel inserted in a saw slot near the heel of the tee. After adjustment, it is cut off, notched and soldered in place. At y and z are blast gates whose slides have been cut off and riveted. Equalizers must be as near tamper-proof as possible. If closely preceded by an elbow, the equalizer should be inserted in the pipe on the same side as the elbow throat. This location will lessen wear and will prevent clogging.

Blast Gates

The use of blast gates is seldom an economy for the reason that the designer must calculate mains for velocities about 50% higher than the minimum allowable values so that closed gates will not cause settlement of material in the pipes. During the times when all gates are open, the friction loss is excessive.

The common blast gate is shown in Fig. 92a. This style is suitable only for small pipes and light duty. A more rigid gate, supported on all sides, is the skeleton blast gate, Fig. 92b. It is especially suited to systems handling fibrous or stringy substances. The lever gate, Fig. 92c, is used in overhead pipes and may be controlled by chain and pulleys.

Ball and Telescope Joints

The cast iron ball joint, Fig. 92d, permits lateral movement of the hood in all directions. Cast lugs and eye bolts permit attachment of stay rods. Slip joints, Fig. 92e, allow axial pipe movement and when connected to ball joints make possible great freedom of hood adjustment.

Cleanouts

The suction main and fan are connected by a sleeve, Fig. 93a. The distance L from the end of the main to the fan casing should be great enough to permit removal of the fan wheel without disturbing the main pipe. Sleeves may be hinged along the side opposite the bolted angles or may be a single rolled sheet, sprung into place. The latter is the tighter connection.

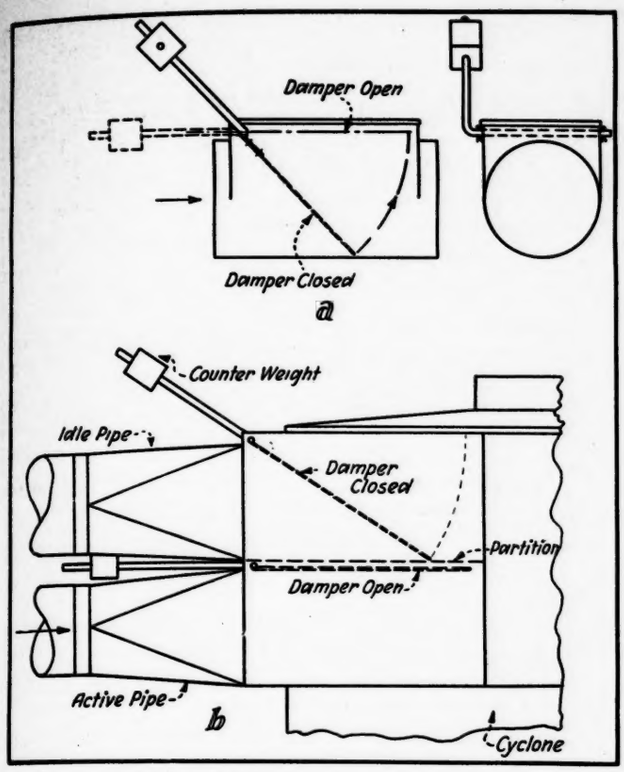

Fig. 94. Back pressure dampers.

Cleanouts should be provided in all mains and in the discharge pipe at intervals of about 10 ft. The blind end of the main should be capped. A handhole should be cut at the lower end of each riser for the removal of heavy objects. Cleanouts are needed near equalizers and in switches and dampers. The slide cover, Fig. 93b, sufficiently dusttight and waterproof for outdoor use, is placed on the side of the pipe. Fig. 93c is a friction cap often used on automatic fire dampers for inspection and replacement of fusible links.

Large doors in dust arresters, cyclones and pressure pipes should be gasketed. They should be of the lift-off type or loosely hinged so that cam clamps can pull them tightly against the gasket.

Back Pressure Dampers

When two or more pipes under pressure enter a dust separator, a back pressure damper in each pipe is essential to prevent reverse flow of dust in any pipe whose fan is idle. The damper should be close to the separator and must be horizontal so that an accumulation of dust on the blade cannot prevent the damper from opening when the fan starts. A damper for installation in round pipe is illustrated in Fig. 94a. Fig. 94b is a multiple damper mounted in a cyclone inlet. Dampers must be ruggedly built, using nothing lighter than 16 gage sheets for the blades and sides.

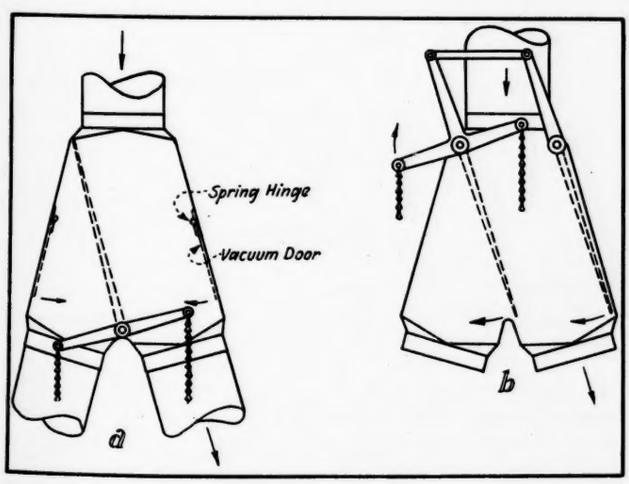

Fig. 95. Switches.

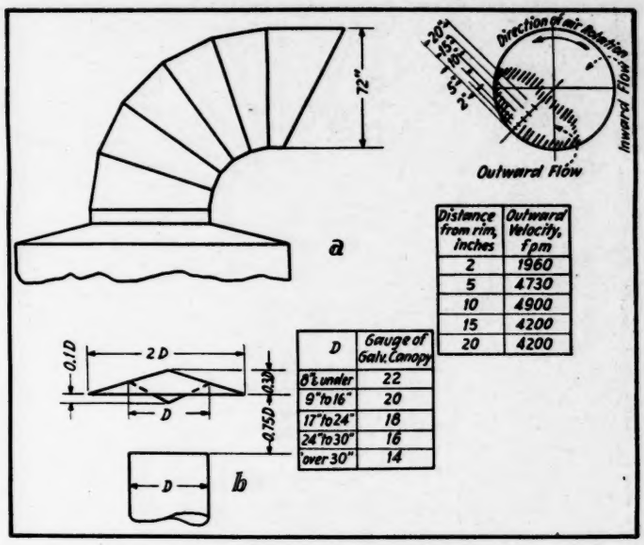

Fig. 96. Storm elbows and canopies.

Switches

A single-blade switch is shown in Fig. 95a and a double-blade, long shavings switch in Fig. 95b. With the flow as shown by the arrows, the latter seldom clogs when passing fibrous materials. The flat sides and blades should be made of 16-gage levelled sheets to insure free action. Handholes are necessary for the removal of refuse caught on the blades or between blade and housing. Sometimes a vacuum door is added to prevent collapse of piping due to the momentary suction formed when the stream is diverted. This is a simple door opening inwardly and closed against a felt gasket by a spring hinge.

Weather Caps

The storm elbow, Fig. 96a, is commonly used to exclude rain and snow from a cyclone outlet. The throat radius may be short and the elbow should bend through 90° or more. It should be reinforced with band iron or angles.

The canopy, Fig. 96b, is cheaper than the storm elbow and is no less effective. The inner cone constitutes both a stiffener and a deflector for the outgoing air. The height of the canopy above the pipe as shown in the cut is satisfactory for fan discharge pipes. When protecting a cyclone outlet, the height may be decreased to 0.6D without measurable increase in resistance.

Pipe Supports

Interior piping should be supported by metallic straps and hangers similar to Fig. 97a. Bands usually are rolled from black iron or angles. Hangers are straight, bent or twisted as required and usually are formed on the job.

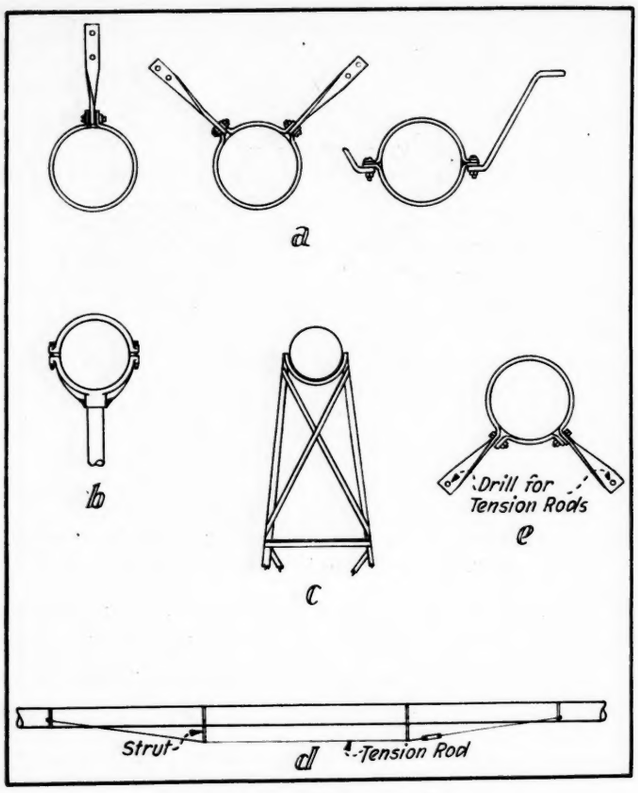

Fig. 97. Pipe supports.

Long runs of outdoor piping of small sizes such as are common in pneumatic conveying may be supported on iron pipe standards set in concrete. The pipe saddle and strap shown in Fig. 97b are cast iron. Steel "A" frames, as in Fig. 97c, are common. When the span between supports is so long that sagging occurs, the pipe may be stiffened by tension rods and struts as shown in Fig. 97d. A detail of the strut construction in Fig. 97e shows how double tension rods may be used to reduce the tendency to sway in the wind.

Reduction of Fire and Explosion Hazard

The following rules for the design of exhaust systems will minimize the likelihood of disastrous fires or explosions.

1. Do not connect spark-producing processes such as grinding to exhaust systems handling combustibles.
2. Install adequate traps to take out heavy metallic objects near the source.
3. Do not run pipes through fire walls unless absolutely unavoidable.
4. Install automatic fire dampers on both sides of each wall through which an exhaust pipe passes.
5. Do not depend on solder for structural strength of any joint.
6. Allow at least 6 in. clearance between exhaust pipes and floors, ceilings or combustible materials.
7. Electrically ground all fans, piping, dust arresters and motors.
8. Treat as explosive all air-borne finely divided solids having considerable calorific value.†
9. When handling explosive substances, locate collectors on the roof or otherwise safely isolated.
10. Nonferrous fans are an added safety precaution against fire or explosion.

For more specific design information, the engineer is referred to the publications of the National Board of Fire Underwriters and the Associated Factory Mutual Fire Insurance Companies.

†This includes flour, starch, grain dust, sugar, milk powder, ground spices, phenolic molding powder, pulverized fuel, wood flour, aluminum buffings, hard rubber dust and sulphur dust.

Ejector Systems

When the conventional system is unsuitable because of high gas temperatures, explosive mixtures or corrosive vapors, the ejector system finds application. As shown in Fig. 98, flow in the exhaust piping is induced by the aspirating effect of a high velocity air jet. Ejector systems require from 5 to 10 times the power of ordinary systems because of the inefficiency of energy transfer between the high speed jet and the induced air.

The nozzle velocity usually lies between 8000 and 15,000 f.p.m. and the ratio of inspirated air to high pressure air is from 3:1 to 6:1. Air ejectors have not been investigated fully. In consequence, our design rules are empirical. The steps are as follows:

1. Calculate the air horsepower of the exhausted air using the volume of induced air and the total or impact pressure in the zone of the high velocity nozzle.
2. Multiply this by 6 to allow for the inefficiency of energy transfer. The resulting figure is the air horsepower of the high speed jet calculated from its volume and velocity pressure.
3. Compute the jet velocity from the expression

$$V = 4674 \sqrt[3]{\frac{\text{Jet air hp.}}{\text{Jet area (sq. ft.)}}}$$

The performance of a straight stack similar to Fig. 98b is not greatly inferior to that of the more elaborate venturi ejector, Fig. 98a. Its cost, of course, is considerably less.

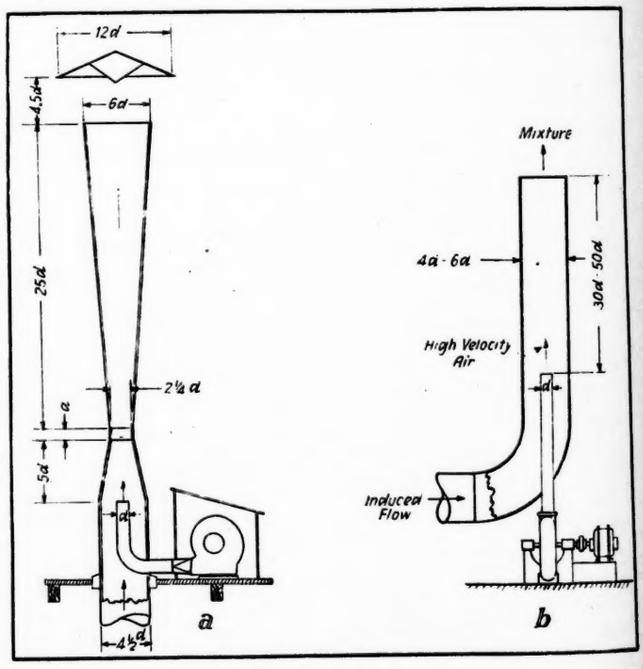

Fig. 98. Ejectors.

System Size

No arbitrary limits can be placed on the maximum size of an exhaust system. Nevertheless it is true that in most instances little is to be gained by connecting to a single unit much more than 1000 sq. in. of branch area. Expressed in terms of fan capacity, about 20,000 c.f.m. for a single fan or 40,000 c.f.m. for a double fan represents a size beyond which a single system becomes unwieldy and inflexible. Machinery rearrangements, system repairs, alterations and accidental shutdowns may prove excessively costly if all exhaust capacity is combined in one unit.

Self-Clearing Mains

Systems with self-clearing mains are valid exceptions to the size limitation previously mentioned. In these systems the material is transported through the branches at usual exhaust velocities but is conveyed through the main by mechanical means or by local air jets. The size of the main at any point is independent of the number and size of the downstream branches, of the air volume and of the velocity. Hence, branches may be moved, added or cut off completely without interfering with the performance of the system.

In Fig. 99a, the material which has settled to the bottom of the main is carried along by a drag conveyor. In Fig. 99b, the propelling agent is a series of air jets issuing from slots in the bottom of the main. Pressure air from a blower supplies the conveying energy in Fig. 99c. In both of the air jet types, the main exhaust fan must be large enough to handle both the air from the hoods and the propelling air.

The main may be straight or may be erected in the form of a closed loop. In the latter instance, it is possible to design the system so that no machine is far

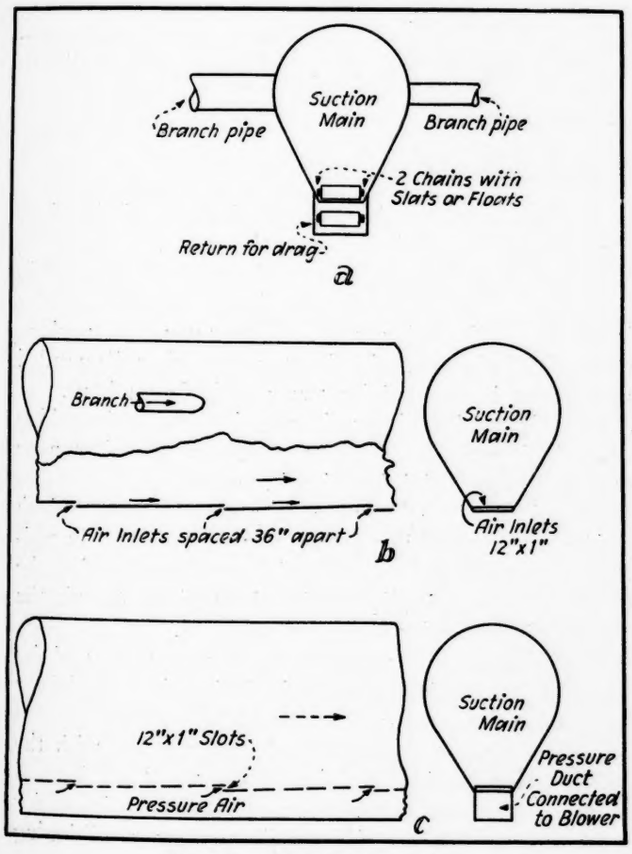

Fig. 99. Self-clearing mains.

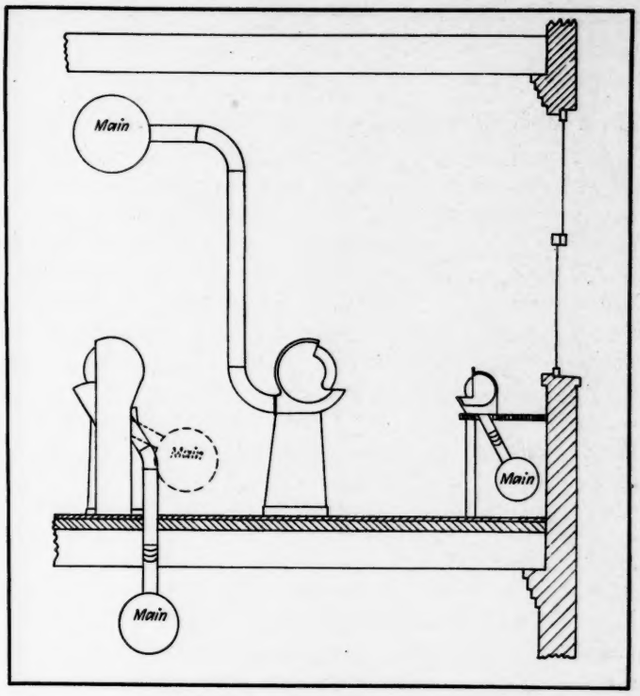

Fig. 100. Exhaust main locations.

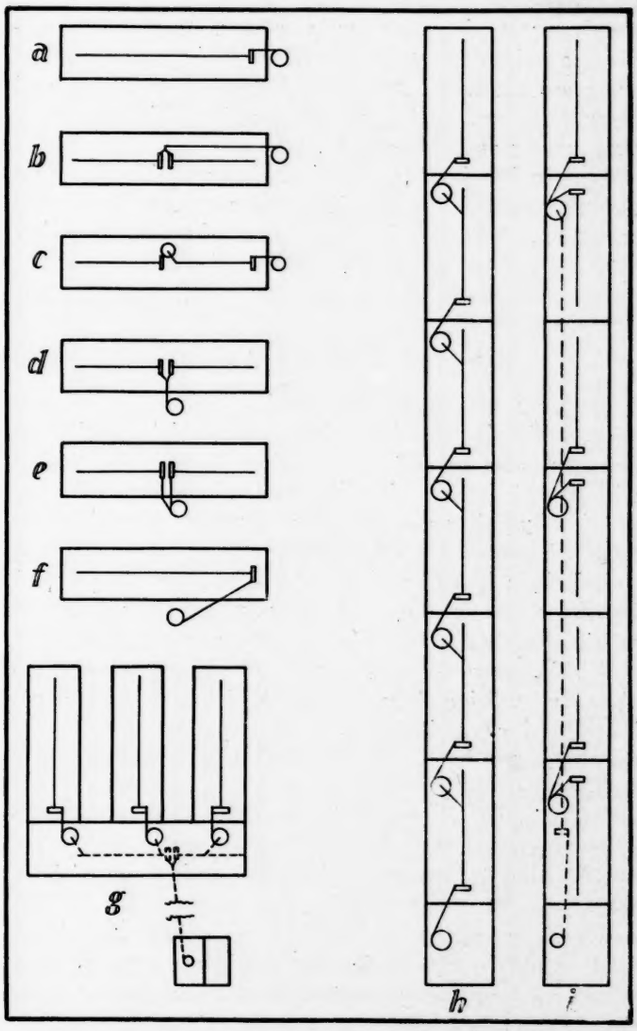

Fig. 101. Typical system arrangements.

from the main and so that complete rearrangement of machinery is possible at low expense. One or more exhaust fans may be connected at convenient points.

Overhead, Floor Level and Under-Floor Piping

Although overhead piping is conspicuous and shuts off light, it saves floor space and can cross aisles without interfering with traffic. Floor level piping, on the other hand takes up usable space unless it can be placed under benches. Housekeeping always suffers, however, when piping is so located. Exposed pipes at working level are subject to damage by trucks and usually block passages between machines. The sole advantage is that branches are short and direct. Under-floor piping combines the advantages of the other schemes but has the drawback of high cost particularly when holes must be cut through concrete or composition floors. Fig. 100 shows the several arrangements.

System Arrangement

In Fig. 101a to f is shown a long narrow building in which the exhausted machinery is distributed fairly uniformly. The first three sketches show the refuse disposal point at the end of the building while the remainder place the collector near the middle of one side.

Unless the building length exceeds 400 ft., Fig. 101a usually is the cheapest layout. While the total pressure developed by the double fan, Fig. 101b is somewhat less than that required by the preceding arrangement, the first cost of the system is greater. In Fig. 101c appears a pair of systems, one of which is purely a gathering system while the other is both a gathering and a relay system. In a very long building this plan saves both power and investment.

The double fan, Fig. 101d, makes possible the most direct system when the dust collector can be located as shown. A flexible but more expensive layout is that of Fig. 101e wherein two independent systems discharge into the same collector. Fig. 101f has neither cheapness nor low power to recommend it.

A mass-production, one-story mill of "E" shape, with a remote boiler house is shown in Fig. 101g. This ground plan invites division into three main gathering systems and a combined gathering and relay system.

In Fig. 101h the 900 ft. building is divided by fire walls into six manufacturing sections and a group of waste vaults. Each gathering system acts as the relay system for the preceding one. While the owners state that the systems have functioned without unusual trouble, the author cannot recommend a long series of tandem systems so completely interdependent.

The preferred arrangement is that of Fig. 101i in which pairs of fans discharge into three large cyclones served by a small relay fan. The first cost is about the same as that of the existing plan although the power consumption is slightly higher. The relay system, shown dotted, must function without failure but it is easier to keep one small but long system in continuous operation than to keep six large ones in service.

Makeup Air

The air withdrawn by the exhaust system must be replaced in such manner that the room atmosphere is not contaminated by flow from other areas at higher static pressures. In addition, workmen must not be subjected to drafts of more than 10F below the general room temperature. Recommended fresh air inlet velocities are‡

Height of Inlet Above Floor, Ft.	Inlet Velocity, F.P.M.
Under 8	120
8 to 12	250
12 to 18	500
18 and over	1000

‡Fundamentals Relating to the Design and Operation of Exhaust Systems, American Standards Association, 1936.

Portable Air Conditioned Rooms for the Tropics

IN the basement of the London School of Hygiene and Tropical Medicine is a room which, to the untravelled visitor, will seem like a Turkish bath, but with the difference that its atmosphere has a higher relative humidity and is therefore more trying. Visitors from Singapore who have been in the room declare that it feels just like Singapore. The temperature and humidity of any part of the tropics can be reproduced in the chamber at will for experimental purposes.

Within the room at present is another room—a portable air conditioned cubicle designed to afford residents in tropical countries relief from the oppressiveness of their climate. It will serve as bedroom, study or simply a refuge from the normal atmosphere. After some years of development the invention is about to go into production, and the model, now on view at the School of Hygiene, is arousing wide interest among visitors to London from the tropics. Besides its more obvious applications, others are being explored by inquirers. A shipping firm is considering the installation of these rooms on hot weather routes for its captains and for those passengers who cannot sleep in ordinary cabins. Another proposal is to use them in the South African gold mines, placing them at the bottom of the shaft for the speedy relief of heatstroke cases.

The standard internal size of the room is about 10 ft. by 6 ft. by 7 ft. in height, but it may be enlarged by inserting additional panels. Two ant-proof packing cases, 7 ft. in length, take the structure when dismantled and it can be erected by two people in an hour.

The air conditioning unit goes into a third packing case. This unit has a ½-hp. motor so that it can be operated from a lighting circuit.

The air conditioning plant is a standard unit which works automatically, reducing temperature and humidity to a comfortable level without attention by the owner. It will be adjusted by the makers to suit the part of the world for which it is ordered.

The idea of this portable room was suggested by Dr. G. P. Crowden, Reader in Industrial Physiology at London University and the School of Hygiene. It has been successfully translated into practice with the collaboration of C. H. Adams. The rooms will be sold at various prices, according to material and interior finish, from $441 to $520, while the air conditioning unit will cost an additional $378.

EDITORIALS

Cost is the Important Housing Factor

For the first time some statistics are at hand to permit a sort of numerical measure of the extent and to determine the location of overcrowding in living quarters. A survey conducted by the United States Public Health Service in 82 widely separated cities covering over 700,000 city households is the source of the figures. Generally the reported results confirm what is well known, namely, that there are many places where there is not enough housing to meet what might be called the needs of the population.

This report standing by itself may mean much or little, but it does shed at least some light on the whole confused housing scene. It shows that crowding is worst in the south and that the crowding is not confined to the large cities. As was to be expected it shows that negroes live with less space per person than do whites. Consequently, it would seem that an expansion of construction would come about as a result of building new and larger quarters for colored families, especially in the south.

So few investors seem to want to undertake this kind of construction that little has been done about it in spite of some outstanding trials and some successful demonstration projects by private companies and by the government. It is in this field that low cost is most urgently needed and where the greatest hope is held for some form of standardized design or prefabrication. The general problem is well understood and is under attack steadily. Only this month a group of building equipment makers went to work on a new approach to the problem.

Shortage there is, overcrowding is prevalent, but how to overcome them while staying within the means of the overcrowded families is still the kernal of the problem just as it has been for the past ten years.

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Good News from U. S. Housing

Several recent announcements concerning the U. S. Housing Authority program are of a heartening nature. One is that it is expected that one of the largest of the apartment house projects in New York is to be constructed at a new low cost per unit, thus permitting the construction of more housing units than had been thought likely. The construction cost reduction also helps to lessen the spread between revenue and operating expense and makes it likely that more private investors will be attracted to the possibilities of erecting apartment houses for rental purposes.

Another point is that the program is progressing as rapidly as expected and a large part of it will be in the construction stage within the next few months. The whole heating industry will surely feel the effects of this program and its progress is one of the factors which make the present outlook so encouraging.

Still another point is that the procedure established in letting contracts for these projects is expected to be under local direction and not under centralized control at Washington. Whatever may be said in favor of central operation, it is undoubtedly true that local builders, dealers, contractors, and engineers do not like the practice. They prefer to operate under familiar conditions and prefer that their dealings shall be with local people. All these groups are therefore likely to be in a much better humor over the proposed procedure than has been the case with much of the government-sponsored building done in the past few years.

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Two Unusual Installations

Two descriptions of recent installations of cooling in this issue are of more than passing interest. Both are in Illinois, where many unusual installations may be found. One is in a church while the other is in a department store.

We do not publish the church story because we expect that any great volume of business in cooling is about to be found in modernizing existing churches. We consider that the story has novelty interest, and also that it shows that even in so unpromising a building type as existing church structures there are cases where air cooling is logical and salable even under present conditions.

The store installation of absorption cycle refrigeration especially designed for air conditioning is among the early ones made. We have previously called attention to the fact that there is a large background of technical interest in this method of refrigeration and in its possibilities for air conditioning. The installation described permits forming a good idea of how far the methods and equipment have progressed. There is a considerable body of opinion which has steadily held that the final form of year-round conditioning will make use of the absorption cycle.

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A Seal for Oil Burners

The past month brought the announcement that a plan is soon to be put in effect whereby oil burners for domestic use will be submitted to a laboratory, put through a series of tests, and those found acceptable will be permitted to display a seal of approval. This will make the use of the seal following a laboratory test just about universal so far as fuel-burning equipment is concerned. Gas equipment has carried a seal for years, more recently anthracite coal equipment has taken up the practice. Now comes oil-using equipment along the same path.

There is little doubt but that a good many burners of questionable quality and performance have been put on the market and that they have done a good deal of harm. To the extent that a seal plan will result in keeping such equipment out of use and will really protect the interest of the user, the manufacturer, and the trade generally, the announcement is all to the good. There is every reason to expect that the plan will work once it has become established, for the other seal plans are apparently doing well.

KINKS

Temporary Pipe Protection

The accompanying photograph shows how temporary piping over a sidewalk was protected by means of concrete. The large pipe against the curb is also temporary. Both were removed after room was provided for them underground.

As a suggestion: When protecting piping on top of a sidewalk in this manner, why not taper the concrete more gradually in the directions of pedestrian traffic? The possibilities of tripping would then be removed. This lump of concrete has sides that are too abrupt, although it must be admitted that protection of this kind is better than no protection at all, and there is less possibility of hurting pedestrians than would be the case if the piping were left bare. But, why not add a little more concrete and do it right?—*W.F.S.*

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Liberal payment will be made for brief articles which are, in the opinion of the editors, useful and generally applicable kinks relating to drafting room, shop, plant, or field practice in the design, installation, operation, or maintenance of heating, ventilating, or air conditioning equipment. Sketches (in pencil) or photos should be included when necessary.

WHAT READERS SAY

Early Fans

Editor, Heating & Ventilating:

The July issue of your magazine shows in Picture Paragraphs a fan of the 1663 period said to be the earliest known mechanical device for circulating air. If a hand-operated crank of a centrifugal fan would be termed a mechanical device, then Agricola's treatise of the metals published about 1540 antedates this, for the woodcuts in that book showed housed fans for ventilating the mines of Bohemia. It is interesting to note that the fan blade forms appear to be tipped with feathers, wooden tips shaped like feathers, and finally a simple paddle wheel fan. President and Mrs. Hoover made a translation of this work some years ago.—*Frederic R. Ellis, Buerkel & Co., Inc., Boston, Mass.*

●

Whitewash for Roofs

Editor, Heating & Ventilating:

On page 24 of the July, 1938 issue of "Heating & Ventilating in the article, "How to Reduce Heat Loads Due to Sunlight on Roofs," you mention a whitewash made with tallow. Is this tallow any special specification and where can it be obtained?—*L. O. A., Louisville, Ky.*

The whitewash was developed by the Building Research Station of the Department of Scientific and Industrial Research of the British Government. In reply to a letter they stated that the tallow used in the whitewash was purchased in the British market under the name "Russian Tallow." From the chemical point of view the material is essentially an impure form of stearin and is the fat extracted either from beef or mutton. Ten parts of tallow are used to ninety parts of lime putty. A convenient method of incorporating the tallow and the lime is to mix the tallow with the quicklime and to slake the two together. The mixture is then brought to the consistence of a cream by the addition of further water. The formula given seems to work quite well, giving a film of reasonable durability which maintains its efficiency under British conditions for a summer season.—*Editor.*

THE PROBLEM CORNER

A pad of cross-section paper and a pencil cost an engineer $1.05. The paper costs a dollar more than the pencil. How much did the pencil cost?

If you are in doubt of your solution, see page 68.

THE MONTHLY QUIZ

How many of the following teasers can you answer offhand? Only one of the answers given after each question is correct. Check your answers against those appearing on page 68

1. The boiling point of refrigerants is (1) always above the freezing point (2) always below the freezing point (3) identical with the freezing point for most refrigerants (4) above the freezing point for most refrigerants (5) below the freezing point for most refrigerants.

2. A cubic foot of space is capable of holding, at atmospheric pressure, the greatest weight of water vapor at (1) 32F (2) absolute zero (3) 70F (4) 1479F (5) 212F.

3. In cold weather, high relative humidity makes us uncomfortably cool; in warm weather, uncomfortably warm. The temperature in still air at which humidity has no effect on feeling of warmth (in other words, the dividing line) is about (1) 0F (2) 68F (3) 46F (4) 98.6F (5) 72.3F.

4. If the pressure against which a fan is operating is suddenly decreased, the motor will tend to be overloaded if the fan is of the (1) forward-curved blade type (2) propeller type (3) backward-curved blade type (4) reversed curve type (5) disc type.

5. An ordinarily active person living in a metropolitan district would in one year breathe in dust amounting roughly to a weight of the order of (1) less than an ounce (2) about a pound (3) about ten pounds (4) nearly sixty pounds (5) approximately his own weight.

ABSTRACTS of Current Papers, Books and Pamphlets

Fluid Flow and Heat Transmission

Thermodynamics, fluid flow, and heat transmission are subjects about which all engineers working in the field of heating and air conditioning must have some knowledge. While these subjects are part of the training of all college-trained engineers, they are practically always treated as separate subjects and not much is done to tie them together as they are encountered in actual engineering problems.

In this book the author has combined this material into one continuing study. While it has been prepared to serve primarily as an outline for a college course, it will be found extremely useful by practicing engineers to review and extend their knowledge of these subjects.

The book presupposes an elementary knowledge of thermodynamics and hydraulics although it includes a review of both of these subjects. Dimensional analysis, fluid flow and heat transmission are taken up in detail. Numerous footnotes and references are given so that the student may obtain additional information.

A list of the chapter headings include Dimensional Analysis; Thermodynamics of Perfect Gases; The Thermodynamics of Vapors and Equations of State; The Flow of Fluids; Measurement of Fluid Flow; Heat Transmission; Engineering Characteristics of Solid Particles in Fluid Streams; and the Compression of Fluids.

[*"Thermodynamics, Fluid Flow and Heat Transmission," by H. O. Croft. Published by McGraw-Hill Book Co., Inc., New York. Cloth cover; 6 x 9 in.; 312 pages; price, $3.50.*]

●

Mathematics for Engineers

The title of this book is misleading in that it would lead one to believe that it is addressed only to engineers and takes up only the engineering applications of mathematics. As a matter of fact it hardly mentions any engineering topic and presents only a small number of practical problems to show how the theory applies. Instead the purpose of the book is to present a unified treatment of the subject of mathematics and to introduce the calculus in a rigorous, practical form. It is this feature which will make the book appeal to many engineers.

Instead of completing algebra, trigonometry, and analytical geometry before starting the calculus, the author selects only those parts which are best treated before the calculus. While it is designed to be used as a textbook it will serve very well as a review book for the engineer who feels that his mathematics has become rusty and needs some polishing.

[*"Essentials of Engineering Mathematics," by J. P. Ballantine. Published by Prentice-Hall, Inc., 70 Fifth Ave., New York. Cloth bound; 6 x 9 in.; 502 pages and 76 pages of mathematical tables. Price, $3.75.*]

Smoke Prevention Manual

The 1938 edition of the Smoke Prevention Manual of Ordinances and Requirements follows much the same outline as previous editions. The aim of the manual is to present information on smoke abatement for municipalities, manufacturers, engineers, railroads, architects, and others interested in smoke abatement.

The main part of the manual is devoted to presenting results of a survey relative to ordinances now in force in various municipalities for regulating the emission of smoke. Included is information on what smoke densities should be prohibited; periods of smoke allowed for starting and cleaning fires; requirements for the installation of fuel burning equipment; penalties for violation of such ordinances; personnel of smoke abatement forces; salaries and equipment required.

Also included are the proceedings of the 32nd annual convention of the Smoke Prevention Association; description of methods of measuring air pollution; a model smoke abatement ordinance; instructions for burning low volatile coal in low-pressure heating boilers; instructions for burning low volatile coal in heating boilers; and instructions for firing bituminous coal.

[*"Manual of Ordinances and Requirements," published by the Smoke Prevention Association, City Hall Square Bldg., Chicago, Ill. Paper cover; 6 x 9 in.; 160 pages, including advertising; price, 50 cents.*]

●

Storage of Fruits, Vegetables and Flowers

The storage of fruits, vegetables, and flowers for commercial purposes involves the rather accurate maintenance of temperature and humidities. If the temperature is too high there is danger of increased decay and undue ripening; if it is too low there is danger of freezing. If the relative humidity is too high the danger of decay is increased, while if too low wilting is likely to occur. It is the purpose of this booklet to present brief summaries of the essential average storage requirements of the more important varieties of fruits, nuts, vegetables, cut flowers, and other perishable commodities.

Included in the first part of the booklet are discussions of the temperatures and relative humidities used in storage rooms and data on the evolution of heat by commodities and the amount of sensible heat to be removed in cooling. Following this are some brief discussions on various types of fruits and nuts, vegetables, cut flowers and bulbs. Information on the recommended temperature and length of storage is also included.

[*"The Commercial Storage of Fruits, Vegetables, and Florists' Stocks," by Dean H. Rose, R. C. Wright and T. M. Whiteman. Circular No. 278, United States Department of Agriculture, Washington, D. C. Paper cover; 6 x 9 in.; 44 pages; price, 10 cents. For sale by the Superintendent of Documents, Washington, D. C.*]

Mechanical Refrigeration Theory

Practically all mechanical engineering and many other engineering students at some time or other during their college course study the theory of mechanical refrigeration. This book is written to meet the needs of these students by presenting a thorough fundamental thermodynamic approach to the subject. Purely descriptive matter and empirical data are left to books of the handbook type.

While the book assumes a knowledge of engineering thermodynamics such as the usual senior may possess, it does include a brief review of thermodynamics. The book should be of interest to all engineers in the field whose knowledge of the fundamental thermodynamic theory is slight either because of a lack of use or because of an inadequate training.

Chapter headings include the following: basic thermodynamics, principles of refrigeration, air refrigeration systems, vapor refrigeration systems, compound vapor compression systems, absorption refrigeration systems, refrigeration in air conditioning, and water vapor refrigerating systems.

[*"Theory of Mechanical Refrigeration," by N. R. Sparks. Published by McGraw-Hill Book Co., Inc., New York. Cloth bound; 6 x 9 in.; 225 pages; price, $3.*]

●

Heat Transfer to Boiling Liquids

In this article the authors demonstrate that a number of the common beliefs concerning heat transfer to boiling liquids do not hold true under all circumstances. The generalities which they claim do not always hold true are: (1) that the overall coefficient of heat transfer to boiling liquids always increases with an increase in temperature differential; (2) that the use of a metal of a lower thermal conductivity will reduce the heat transfer rate; and (3) that the fouling of the surface reduces the rate of heat transfer.

Recent tests have shown that as the overall temperature difference is increased, the rate of heat transfer at first rises rapidly, then increases more slowly, goes through a maximum, then drops rapidly and finally increases.

When the temperature difference between the boiling liquid and the hot surface is small, the liquid which comes in contact with the surface is superheated and small bubbles form on the surface. These bubbles grow rapidly and finally break away from the surface. When the temperature differences are much larger, the liquid does not come in contact with the metal but is separated by a layer of vapor which forms an insulating blanket through which the heat must be transferred. This condition occurs when the temperature of the surface is only from 30F to 100F above the boiling point of the liquid.

One of the experiments conducted by the authors of this paper brought out this very clearly. Ethyl acetate was heated by a ½ in. O.D. aluminum tube through which steam was passed. When steam with a gage pressure of 40 lb. per sq. in. (temperature difference 120F) was used, the heat transfer rate was only 14% of that when the steam pressure was 12 lb. per sq. in. (temperature difference 73F). Even with steam at 2 lb. per sq. in. the rate was 450% of that with 40 lb. steam.

With boiling water heated by steam pipes one set of tests showed that the temperature difference at which the rate of heat transfer was a maximum was approximately 108F for a copper tube, 120F for a chromium plated copper tube, and 130F for an iron tube. The corresponding rates of heat transfer were approximately 2350, 2650, and 2900 B.t.u. per hr. per sq. ft., respectively. With temperature differences greater than this the heat transfer rate fell off sharply.

It should be noticed that in this latter test the rate of heat transfer was greater with an iron tube than with either a copper or chromium plated copper tube. In all of the experiments with many liquids and with tubes of iron, copper, chromium plated copper and aluminum the iron tubes always gave the maximum rate of heat flow.

The experiments also showed that as the tubes became aged and a slight amount of scale was found the overall rates of heat transfer were increased. This was noticed with the copper tubes and was attributed to the fact that the slight roughness on the surface due to the scale had a beneficial effect on the liquid side coefficient of heat transmitted.

[*"Heat Transfer to Boiling Liquids," by E. T. Sauer, H. B. H. Cooper, G. A. Akin and W. H. McAdams. Published in the September, 1938 issue of "Mechanical Engineering," 29 W. 39th St., New York. Pages 669 to 675.*]

●

Hydrogen Cyanide Vapor

This is the second booklet of the series on detecting toxic gases in industry which is being published by the Department of Scientific and Industrial Research of the British government. Hydrogen cyanide is manufactured mainly for use in the fumigation of ships and buildings although it is occasionally encountered in certain industrial processes. The test recommended consists of drawing a sample of the suspected atmosphere by means of a hand exhausting pump through a piece of specially prepared test paper. These test papers are treated with Congo red-silver nitrate and benzidine-copper-acetate and are capable of detecting concentrations down to one part in 100,000. The stain obtained on these papers is then compared with a standard chart of stains included with the booklet.

[*"Hydrogen Cyanide Vapor," leaflet No. 2. Prepared by the Department of Scientific and Industrial Research. Paper cover; 9 pages; price, 5s. 6d. Obtainable in this country from the British Library of Information, 270 Madison Ave., New York, for $1.65, including postage.*]

BRIEF REVIEWS

FUEL OIL STANDARDS. Fourth edition of the commercial standards for fuel oil. Standard became effective for new production on May 31, 1938. [*"Fuel Oils Commercial Standard CS12-38." Published by the United States Department of Commerce and the National Bureau of Standards. Paper cover; 6 x 9 in.; 20 pages; price, 5 cents. For sale by the Superintendent of Documents, Washington, D. C.*]

ORCHARD HEATING. A review of the engineering factors involved in orchard heating in California. Includes information on outdoor heating practice, orchard heating experiments, differences in heat output of different types of heaters and orchard heating operations. [*"Engineering Factors Involved in Orchard Heating," by F. A. Brooks. Published in the September, 1938 issue of "Mechanical Engineering," 29 W. 39th St., New York, N. Y., pages 677 to 681.*]

CHIMNEY DESIGN. A practical treatise dealing with the materials and methods of designing brick, reinforced concrete and steel chimneys for all purposes. Gives information on types of chimneys, design of draft, stresses, and comparative costs. [*"Chimney Design," by D. A. Molitor. Published by the Peters Co., 243 W. Congress St., Detroit, Mich. Paper cover; lithographed; 9 x 7 in.; price, $2.50.*]

SILICOSIS. A summary of knowledge concerning the cause and prevention of silicosis. [*"Silicosis and Similar Dust Diseases," by R. R. Sayers and R. R. Jones. Published in the Public Health Reports, August 19, 1938 issue, pages 1453 to 1472, United States Public Health Service, United States Treasury Department, Washington, D. C. Price, 5 cents. For sale by the Superintendent of Documents, Washington, D. C.*]

COMFORT AIR CONDITIONING. A third edition, revised to eliminate obsolete and out-of-date material and to add the latest developments of the art. Purpose of the book is to present information on the fundamentals, design, and installation of comfort air conditioning systems. [*"Air Conditioning for Comfort," 3rd Edition, by Samuel R. Lewis. Published by Keeney Publishing Co., Inc., Chicago. Cloth bound, 6 x 9 in., 286 pages. Price $2.50.*]

VENTILATION. The purpose of this book is to make a general survey of the subject of ventilation and air conditioning rather than to advance new theories. The book discusses the subject in a general manner. [*"A Handbook on Ventilation Including Air Conditioning," by Percy L. Marks. Published by the Technical Press, Ltd., Ave Maria Lane, E. C., London. Price, 7s.6d.; approximately $1.90.*]

ATMOSPHERIC POLLUTION. A report of observations on atmospheric pollution in England for the year ending March 31, 1937. Gives information regarding observations made with deposit gages and automatic filters, measurements of sulphur pollution, daylight and ultraviolet radiation and the effect of the site of the station upon recorded observations. [*"Investigation of Atmospheric Pollution." Department of Scientific and Industrial Research, Great Britain. Paper cover; 9 x 11 in.; 161 pages. Obtainable from the British Library of Information, 270 Madison Ave., New York; price, $2.15.*]

COOLING PONDS. Describes experiments with chemicals for eliminating algae from the water in cooling ponds. Author recommends spraying 160F solution of copper sulphate on the top of the pool. Solution is made of 1.1 lb. copper sulphate and 7.5 gal. of water. [*"Fighting Cooling Pond Algae," by Elton S. Pages. "Power Plant Engineering," 53 W. Jackson Blvd., Chicago, Ill., pages 175 and 176, March, 1938.*]

STANDARD PLUMBING DETAILS. A collection of 119 plates showing the piping details and space requirements of modern plumbing. Due to the great differences in codes all plates have been drawn to meet the more general codes now in use, as well as the best engineering practice, so that any plate can be made to meet local requirements by simply adding or eliminating any part as needed. Includes 42 plates on plumbing fixtures, 37 on plumbing equipment, 16 on plumbing systems, and 24 on plumbing layouts. Eight of these plates on plumbing equipment deal with service hot water heating, two with water connections to street mains, one with pipe hangers and supports, and four with tanks. [*"Standard Plumbing Details," by Louis J. Day. Published by John Wiley & Sons, Inc., New York. Cloth bound; 9½ x 12 in.; 119 plates; price, $6.*]

HEAT TRANSFER. Discusses the heat transfer from condensing steam to cool metal surfaces. The author shows that the rate of heat transfer is greatly influenced by the wettability of the surface. If the cooling surface is wettable the condensation produces a continuous film of liquid and the heat transferred must pass through this liquid film. On non-wettable surfaces condensation takes place in the form of droplets and the heat transfer may be ten or twenty times as rapid as for film condensation. [*"Heat Transfer in the Condensation of Steam," by Margaret Fishenden. Published in "Engineering," 35 Bedford St., Strand, London, W.C. 2, England, pages 643 to 645, June 10, 1938.*]

DEHUMIDIFICATION. A review of the dehumidification of air and gases by adsorption and absorption. The discussion is limited to drying air and gases to make them suitable for drying materials. Presents information on kinds of drying agents, characteristics of drying agents and typical adsorption and absorption cycle. Adsorption and absorption curves for various drying materials are also included. [*"Chemical Dehumidification of Air," by Arnold Weisselberg. Published in "Chemical & Metallurgical Engineering," 330 West 42nd St., New York, pages 418-421, August, 1938 issue.*]

BOILER EMBRITTLEMENT. Paper describes a new method of testing with actual samples of boiler water to determine whether they will cause embrittlement. [*"Testing Boiler Waters for Embrittlement," by F. G. Straub and T. A. Bradbury. Published in the August, 1938 issue of "Combustion," 200 Madison Ave., New York. Pages 29 to 32.*]

HEATING IN GERMANY. A special issue devoted to a review of the progress achieved in power, heating, and ventilating in Germany. The section on heating is made up of the following articles: Heating and Ventilating in Germany in the Last Ten Years; Large Capacity Heating Installations for Industrial Purposes; Designing Central Heating Installations with a View to Economizing in Materials; The Control of Heating Installations in Factories; and Gas as a Fuel. The section on ventilation includes articles on the evolution of air moistening installations for industrial purposes; modern air conditioning installations; and the automatic regulation of air. [*"Power, Heating, Ventilation," special issue of Der Maschinenmarkt, Possneck, Germany. August 24, 1938.*]

NEWS OF THE MONTH

Four Associations and FHA Cooperating on Minimum Standards for Heating of New Houses Insured Under Title II

WASHINGTON—A program of cooperative effort between four large subdivisions of the heating industry and the Federal Housing Administration has been under way for the past three months. The goal is the formulation of simple and workable rules of procedure in the selection of house-heating equipment so that the various equipments will be coordinated to produce maximum operating efficiency. Cooperating with FHA in this work are the Boiler & Radiator Manufacturers Institute, Steel Heating Boiler Institute, Oil Burner Institute, and the National Warm Air Heating & Air Conditioning Association.

The aims of the committees appointed by the manufacturer groups include (1) the drawing up of a code of minimum requirements for house heating of different types; (2) the preparation of instructions, rules, and formulas of a simple nature for the use and guidance of FHA field inspectors in inspecting and checking house-heating systems; (3) preparation of a general information bulletin on selection, sizing, and coordinating the various parts of house-heating plants, and (4) preparation of a bulletin dealing with the heating of multi-family structures. All of these will apply only to new buildings where FHA is insuring the loan under Title II of the National Housing Act, but it is believed that the work of the committees may eventually be widely adopted and recognized.

The warm air furnace committee was the first to accomplish tangible results. Following a meeting of the committee on July 7, the inter-organization instructions for warm air are already completed and in use in the field. The committee later met early in August to formulate standards of construction of warm air furnaces similar to the ASME boiler code of the radiator heating industry.

Later the Oil Burner Institute appointed a committee to set up minimum performance specifications for oil burners for residential use. The Institute has drawn up and approved such a code and has undertaken to issue OBI Seals of Approval to those burners which meet the code under tests made at Lehigh University, and printed in full elsewhere in these columns. It is contemplated that FHA will require such approval at such date as the industry is prepared to meet such requirements.

The Boiler and Radiator Manufacturers Institute committee held its first meeting July 13 in New York and is at present at work on a standard method for sizing boilers for house-heating. A later meeting was held late in September.

The Boiler and Radiator Manufacturers Institute preliminary committee consists of J. F. McIntire, U. S. Radiator Corp.; Max Rose, American Radiator Co.; E. I. Boardman, Richardson & Boynton Co.; A. E. Bastedo, Burnham Boiler Corp. Representing the FHA in working with this committee are R. K. Thulman, Technical Division; Vincent Carlin, Underwriting Division, and E. H. Macy, Technical Division.

The National Warm Air Heating & Air Conditioning Association committee is made up of C. W. Nessell, Minneapolis-Honeywell Regulator Co.; J. E. Maynard, Fox Furnace Co., and Prof. L. G. Miller, Michigan State College. Oil Burner Institute's committee is composed of M. A. Powers, Timken-Silent Automatic; T. H. Smoot, Fluidheat Corp., Div. Anchor Post Fence Co.; W. O. Lum, General Electric, and G. Harvey Porter, managing director of OBI. R. K. Thulman represents FHA in cooperating with the last two committees.

Phila. Engineer Changes Address

PHILADELPHIA—Morris Fruchtbaum, packing house engineer and architect, has removed his offices to Suite 200, Wood Building, 400 Chestnut St.

India Pleased with Railway A. C., May Expand This Service

MONTREAL, QUE.—The air conditioned railway cars placed in service in India a few months ago are proving of great value to travellers in that country, according to N. L. Fisher, manager of Cook's travel agency in Calcutta, India. Mr. Fisher, who has been visiting in Montreal, stated that the generous public acceptance of the new cars would likely lead to the general adoption of air conditioning by the railways of India.

According to *The Heating and Ventilating Engineer* (Great Britain), an experimental extension of air conditioned travel to sections of the Northwestern Railway between Lahore and Karachi and Peshawar and Delhi is expected next winter. An attempt will be made to ascertain which of the two types of air conditioning now adopted on Indian railways will suit these sections.

It is stated that the less costly type of air conditioning in vogue on the B. B. and C. I. Railway requires a daily minimum guarantee of three first-class passengers; while the system adopted on the Calcutta-Bombay section of the G. I. P. Railway requires a much larger guarantee. The authorities will first try to discover whether traffic on the two sections can bear introduction of either of these two types. The Northwestern Railway will shortly put 11 rail cars on selected sections.

10,803 A.C. Railway Cars in Use

CHICAGO—The Association of American Railroads announced that Class I railroads and the Pullman Company had air conditioned 1,384 passenger cars in the year ended July 1. Of that number railroads air conditioned 1,003 and the Pullman Company, 381. Total number of air conditioned cars in operation on July 1 was 10,803 compared with 9,419 a year earlier. Of the number in operation on July 1, 1938, 5,862 were owned by the railroads and 4,941 by Pullman.

Some of the engineers on committees working to set up minimum heating standards. Left to right: J. F. McIntire, Max Rose, Prof. L. G. Miller, M. A. Powers, G. Harvey Porter, and R. K. Thulman. Mr. Thulman's photo by Harris & Ewing.

Oil Burner Institute to Grant Approval Seals for Oil Burners; Burners Must Pass Laboratory Tests at Lehigh

NEW YORK—The oil burner industry now has an approval seal service similar to that which has been in use for some years by the gas industry and the anthracite industry. Oil Burner Institute has announced that the OBI seal of approval will now be placed on oil burners made not only by manufacturers who are members of the Institute but those made by other manufacturers as well, provided the burner is approved by the Underwriters' Laboratories and in addition passes tests to be made by Lehigh University.

In order to make available approved equipment by October 31, Lehigh is now issuing temporary certificates. Federal Housing Administration will require, by that date, the seal of approval to be on all burners installed after that date in homes insured by FHA under Title II of the housing act. A fee of $75 payable to Lehigh University must be submitted with application for test and approval of each burner model. Upon notification from the university that a burner has met the requirements, OBI will supply approval seals to the manufacturer.

The OBI approval requirements for mechanical draft oil burners are as follows:

Long Hour Motor: Oil burner motor service may be assumed to be equivalent to continuous operation and the motor shall be of ample capacity and designed for long hour duty, and be so designated by the motor manufacturer.

Radio Interference: The burner shall be reasonably free from radio interference.

Materials Standards: The burner shall be constructed in its assembly, its sub-assemblies and all parts of materials built to limits recognized as meeting the best prevailing standards for long mechanical life. Parts, subject to wear, shall be easily replaceable.

Quietness: The burner shall be reasonably free from disturbing combustion or mechanical sound.

BURNER PERFORMANCE RATINGS

CO_2 Rating: Burner shall be capable of producing and maintaining a CO_2 reading of not less than 10% without visible smoke at oil rates of 1 gal. and over. At oil rates of less than 1 gal. per hr. the minimum CO_2 shall be 8%.

Burner Safety: The burner shall meet the safety standards of Underwriters' Laboratories, Inc.

Controls: Burner controls to be shipped by burner manufacturer as part of the burner equipment shall consist of the following as a minimum for heating installations: primary control, limit control, and thermostat or equivalent.

Burner Guarantees: Burner and burner controls shall be guaranteed by the burner manufacturer against defects of material and workmanship for a period of one year from date of installation.

BURNER TEST ARRANGEMENT

Manuals: Printed comprehensive service and installation manual shall be submitted by the burner manufacturer to the OBI authorized laboratory for approval.

Tests: Burner test for OBI certification shall be conducted according to test procedure formulated by the OBI Standards Committee and approved by Oil Burner Institute.

BURNER CERTIFICATION

The presence of the OBI Seal of Certification on the burner is evidence that the burner meets the above standards.

The Oil Burner Institute recommended requirements for installation, operation, and service of mechanical draft oil burners are as follows:

Installation Regulations: Installation shall be made in accordance with local regulations, codes or ordinances.

Local permits and certificate of inspection to be obtained by the installer, expense thereof to be borne by the installer.

The burner must have an OBI rated capacity sufficient to fire the boiler or furnace at its minimum firing rate. This minimum firing rate shall be specified by the Institute of Boiler and Radiator Manufacturers or equivalent furnace authority.

Draft Regulators, Etc.: The burner installation shall be equipped with an automatic draft regulator or its equivalent, as approved by the OBI Standards Committee.

Combustion Chambers: The combustion chambers shall be constructed of materials as supplied or recommended by the oil burner manufacturer.

Fuel Specified: The burner shall burn the commercial standard fuel specified in the listing of Underwriters' Laboratories.

Service: The burner installation shall be protected by a written guarantee of one year's service from date of installation, without extra charge. This service during the heating season shall be available 24 hours per day.

Chimney Sizes: Chimney sizes and heights shall be in accordance with the boiler manufacturers' recommendations.

Knisely Heads Industrial Advertisers

CLEVELAND—Stanley A. Knisely, advertising manager of Republic Steel Corp., was elected president of the National Industrial Advertisers Association at the final business session of its convention held here last month.

Advisory Committee of Statistics Appointed by Gas Appliance Makers

NEW YORK—The appointment of an Advisory Committee on Statistics for the Association of Gas Appliance and Equipment Manufacturers has been announced by Merrill N. Davis, president of the association.

The principal functions of the Advisory Committee will be to decide on questions of statistical policy, and determine the kind of statistics to be gathered and disseminated.

H. N. Ramsey, president of the Welsbach Company, of Gloucester City, N. J., will serve as chairman of the committee. The other members are: W. E. Derwent, vice-president, George D. Roper Corporation, Rockford, Ill.; J. S. Drillette, vice-president, Peerless Manufacturing Company, Louisville, Ky.; R. G. Logue, vice-president, Ward Heater Company, Los Angeles, Calif.; H. P. Mueller, president, L. J. Mueller Furnace Company, Milwaukee, Wis.; F. E. Sellman, vice-president, Servel, Inc., New York, and John Van Norden, secretary, American Meter Co., N. Y.

A.C. Improves Value of Submarines

WASHINGTON—Air conditioning now being installed in submarines will make America's undersea fighting force a much more potent weapon in any future war, according to William B. Henderson, executive vice-president of the Air Conditioning Manufacturers' Association, who quotes Lieut. Albert R. Behnke of the Navy Medical Corps as saying that the efficiency of submarines depends primarily on the fitness and comfort of personnel during long cruises at sea.

Air conditioning promises to make possible operation at sea for increased periods of time, according to Lieutenant Behnke. This will extend the crafts' range and, accordingly, their effectiveness in meeting an enemy vessel at a distance from American shores.

The use of cooling and dehumidifying equipment and the provision of oxygen from tanks to replace exhaled carbon dioxide will enable submarines to run submerged probably for periods of days, thus adding another factor to their effectiveness in attack or defense.

Few realize the difficulties under which submarine crews work. The men must rebreathe the same air for periods of from 3 to 24 hr., perhaps longer, under war conditions. They must live in very cramped quarters, in which all that a sailor owns must be stored in space about the size of his own body. When the vessel is submerged, particularly in tropical waters or during the summer, the temperature may rise to 100F or above, and the humidity may increase to the dewpoint so that sweating is impossible.

Simonds Saw to Occupy A.C. Plant

FITCHBURG, MASS.—Simonds Saw and Steel Company has decided to move into its new windowless plant here. The plant was built in 1931 but never occupied due to the depression.

The original idea of building this windowless factory was to provide working conditions for the factory employes which would equal those of any executive office. It was found through experience that the amount of light in the ordinary plant with windows varied greatly in the different seasons of the year as well as on bright and cloudy days. It also was found that the variation in temperature in the ordinary plant, due to atmospheric conditions, would be improved if the temperature could be controlled. It was also found that noise was disturbing to workmen, and anything that could be done to eliminate this noise would lessen the strain on the operators. Therefore, it was decided that the nearest approach to ideal conditions for our employes could be obtained only through the development of such a windowless plant.

The plant covers almost five acres and is all on one floor. There are no partitions whatever in the plant. The plant is completely air conditioned with a system which provides 50,000 c.f.m.

Jaros to Give A.C. Course at N.Y.U.

NEW YORK—The New York University School of Architecture and Allied Arts will give a course in air conditioning in the second semester. The instructor will be Alfred L. Jaros, Jr., and the course will deal with the reasons for air conditioning, various physiological and physical factors that determine the necessary results, computation of quantities involved, the character of equipment necessary, layout and coordination of various portions of an air conditioning plant and will also include details on specifications and contracts. Registration for the second semester will be from January 26-28.

No A.C. for Needle Trades School

NEW YORK—The projected skyscraper High School of Needle Trades which will cost more than $4,500,000 will be begun shortly, plans having been approved by the board of education. At the request of the board of estimate, however, the air conditioning plant to have cost $250,000 will not be installed.

WPA Spent $7 Million for Heating

WASHINGTON—Approximately $700,000,000 was spent in the purchase of equipment, materials, and supplies for WPA projects in the three years ending last June 30. Of this, $7,100,000, or 1% of the total, was for heating and ventilating equipment.

A.C. Installations Up 31% in Boston

BOSTON—Air conditioning installations in the Boston Edison Company's territory for July totaled 142 hp. for some 12 different concerns and locations, and for August, from the first to the 26th, 18 installations, totaling 111½ hp. August installations were mainly of units, for offices, a jeweler, the oratory of a church, several stores of a candy chain, a restaurant and a photographer, and one residence.

During the first seven months of the year, with all figures checked, there was a 31% increase in the number of installations and a 7.3% increase in horsepower over the installations and horsepower added in 1937. Last year 1068½ hp. were added in seven months and for the same seven months this year 1146¾ hp.

Smoke Preventors Plan Exhibit

CHICAGO—The 33rd annual convention of the Smoke Prevention Association will be held in the Hotel Schroeder, Milwaukee, June 13-16. In conjunction with the convention a Fuel Burning and Air Pollution Exhibition will be held at the Milwaukee Auditorium under the auspices of the association.

The purpose of the program will be: (1) To make possible a visualization of air pollution problems, its prevention and control; (2) to provide a personal program for the average citizen; (3) to crystallize and instill in the minds of local citizens the purpose and necessity of smoke department and air pollution surveys, and to obtain public support for smoke ordinance enforcement.

Stevens Tech. Offers Night Courses

HOBOKEN, N. J.—Stevens Institute of Technology for the first time is offering during the academic year 1938-1939 a program of evening graduate courses. This program supplements the day graduate work which has been given for several years. In developing its new educational project the faculty has considered the needs and interests of graduate engineers employed in the metropolitan area. Coordinated groups of related courses are offered in the fields of mechanical engineering, electrical engineering, and economics of engineering. With the exception of a few noncredit courses, each course carries credit in one or more approved programs leading to the degree of Master of Science.

Included are courses in air conditioning, steam power plants, and mechanics of fluids.

Inquiries and applications for registration should be addressed to Prof. Frank C. Stockwell, chairman, Committee on Graduate Instruction, Stevens Institute of Technology, Hoboken, N. J.

British A.C.Load Now 70,000 H.P.

TORQUAY, ENG.—An interesting lecture on air-conditioning was delivered by Captain J. C. Chaytor at the annual convention of the Incorporated Municipal Electrical Association, held here recently. Captain Chaytor said that in England, unlike America, there was little demand for summer cooling, and the majority of air-conditioning plants so far installed was for all-the-year-round use. Excluding installations for national defense purposes (such as providing purified air for gasproof shelters), the lecturer estimated that the air-conditioning load in Britain at the end of 1937 totalled 70,000 h.p. The figures for consumption vary considerably, but a large factory in Central England with an installed horse-power of 350, consumes 875,000 kwh per annum, and a textile factory, in which one-half the motors operate for 7,350 hours per annum, and the remainder for varying periods during the summer months, consumes 1,350,000 kwh. A restaurant in London, with 687 h.p. installed, used 802,000 kwh in 1937, and the manufacturer of an all-electric self-contained unit conditioner stated that the consumption was 5,000 kwh per annum. This unit is fitted with a ¾-h.p. compressor motor, a 1/30-h.p. fan, and heating elements of 2,100 watts.

In the discussion which followed Capt. Chaytor's lecture, B. Ackery expressed the opinion that the growth of air-conditioning in Britain would not be very spectacular, and added that electricity need not be the motive power.

A.C. Cuts Cancelled Dental Dates

BOSTON—One of the most noticeable results of air conditioning in the dental office of Dr. C. W. King of this city has been the reduction in cancelled appointments during the summer months. Previous to installation of air conditioning, patients often postponed visits until cooler weather, which not only disrupted the daily schedule, but was also detrimental to the patient, as minor troubles of the teeth neglected occasionally developed into something more serious. Doctor King and his assistants also were able to work with far less fatigue than before the offices were air conditioned.

USHA Contracts Total $200 Million

WASHINGTON—Contracts for loans by the United States Housing Authority to local housing authorities for building slum clearance and low rent rehousing projects have now passed the $200 million mark. Projects are now under way in 43 cities. The USHA has signed loan contracts for the construction of 40,636 family dwelling units for more than 160,000 slum dwellers.

Candy Chain Cuts Spoilage with A.C.

BOSTON—Summer weather is the cause of one of the most serious problems in the candy trade, since high temperatures and high humidity tend to not only spoil the appearance of candy, but often make it unsalable because it has softened and become sticky. This represents a great annual loss. Thus air conditioning has come into play, with the result that overhead and loss by spoilage has been reduced, and business increased. Customers continue to buy candies during the summer months, though perhaps different varieties than they purchase in the winter months. The overpowering odors of sweets in the shops is reduced, the candy looks more tempting and shopping itself is more comfortable.

Originally intended as a means of preserving the candy in hot weather, the first installations of the Fanny Farmer Candy Shops proved so profitable that this concern now has air conditioned over sixty stores.

"Wherever we have installed air conditioning," says W. C. Seaton, manager of the New England shops, "loss by spoilage and discoloration has been completely eliminated and our candies retain their original freshness at all times. We would have felt amply repaid for our investment if this was the only result. However, we found that the cool comfort and clean air of our stores was a definite sales stimulant and a substantial increase in business was noted in each store after it was air conditioned."

From the firm's records of the past four years, Mr. Seaton estimates that the average installation pays for itself in each store in slightly less than two years. Because of this the company plans to add a definite number of systems in its chain each year.

Boston A.C. Group Sponsors Outing

BOSTON—A special meeting of the Air Conditioning Bureau was held September 1 to hear Dr. Ethan Allan Brown give an informal talk on the "Value of Air Conditioning in the Treatment of Hay Fever and Asthma."

The fifth annual outing of the Bureau was held September 23 at the New Ocean House, in Swampscott, where the most successful outing the members had ever had was held last year on the same date. Participating organizations included the local chapters of the ASHVE, ACMA, ASRE, and the Boston Oil Burner Associates, Boston Real Estate Exchange, New England Gas & Electric Association, and others interested in various phases of the air conditioning industry.

The general committee was headed by Julius Daniels, past president of the Bureau.

Assembly of Sales Data Described

PITTSBURGH—R. D. Van Houten, vice-president of the Sales Analysis Institute of New York, spoke on "Engineering Your Sales Presentation" at the first fall meeting of the Pittsburgh chapter of the ASHVE September 12.

Mr. Van Houten's subject dealt with the importance of analyzing sales presentations, based on business facts, collected in the same way as engineers gather their data. The speaker used charts to emphasize the importance of logically assembling the necessary data which would result in closing a sale. References to actual sales cases and methods of approach as used by a number of salesmen were made.

To Set Up Conductivity Standards

PITTSBURGH—F. C. Houghten, director of the ASHVE research laboratory, has been appointed chairman of a newly formed joint ASHVE-ASTM Committee on Conductivity to determine national standards for the measurement of conductivity. Serving with Mr. Houghten as representatives of the ASHVE will be Prof. F. B. Rowley, University of Minnesota, and Prof. Gordon Wilkes of MIT. The ASTM members will be H. C. Dickinson of the National Bureau of Standards, Prof. E. R. Queer, of The Pennsylvania State College, and R. H. Heilman of Mellon Institute. The National Research Council and the ASRE will also appoint representatives.

Charles Joseph Thale

MOUNT VERNON, N. Y.—Charles Joseph Thale, heating and air conditioning engineer and vice-president and a director of Almirall & Co., New York, died here September 26 after a brief illness. He was 54.

A graduate of Purdue University, Mr. Thale joined Almirall in 1910, serving as manager of the Chicago office before coming to New York in 1927.

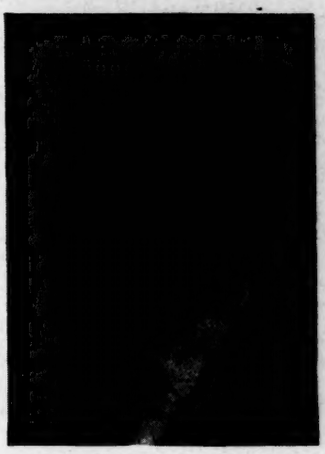
Mr. Thale is survived by his widow and two daughters.

William Folterman, Jr.

NEW YORK—William Folterman, Jr., a field engineer in the oil heating division of National Radiator Corp., Johnstown, Pa., died September 12 in the Post Graduate Hospital of this city. He had been ill about six weeks. He was 40.

L. A. McGuigan

PITTSBURGH—L. A. McGuigan, 62, the second oldest salesman in total years of service in the National Radiator Corp., Johnstown, died suddenly September 8 at his home here. Mr. McGuigan had operated in the Pittsburgh area continuously from 1909 until his death.



James David Hoffman

WEST LAFAYETTE, IND.—Prof. J. D. Hoffman, for the past 49 years a well-known teacher of engineering subjects, died unexpectedly August 14. On June 30 he had retired as professor of practical mechanics at Purdue University.

Born in Auburn, Ind., January 23, 1868, Professor Hoffman studied mechanical engineering at Purdue. He served an apprenticeship in the Auburn Foundry and Machine Works and was an expert in foundry work and pattern making, as well as in heating, ventilating, and power plant equipment. He worked for Buckeye Engine Co., Salem, Ohio, and then joined the staff at Purdue in 1890. In 1911 he joined the College of Engineering at the University of Nebraska as professor of mechanical engineering and practical mechanics, returning to Purdue in 1918 as professor of mechanical engineering and head of the department of practical mechanics.

Professor Hoffman was the author of a number of books, perhaps the best known of which is the Handbook of Heating and Ventilation which appeared in several editions. He was president of the ASHVE in 1910 and presented numerous papers on warm air heating before the Society in its early days when that method of heating was not widely accepted by engineers. He helped frame the Standard Code for the installation of warm air furnaces, as well as the later code on forced warm air systems. He was a life member of the ASME and the Society for the Promotion of Engineering Education, and an honorary member of the NDHA and NWAH & ACA. He was a member of Tau Beta Pi, Sigma Tau, and Sigma Xi.

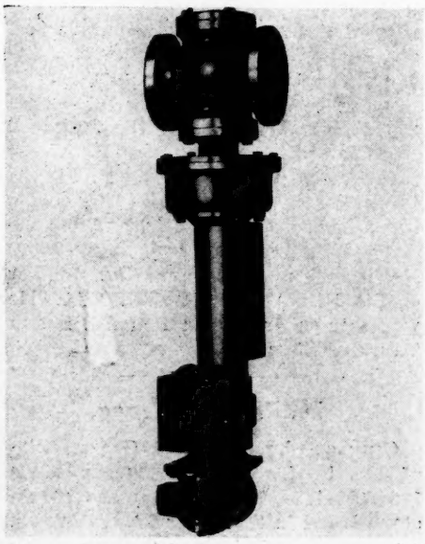
Dr. Willis R. Gregg

CHICAGO—Dr. Willis R. Gregg, chief of the U. S. Weather Bureau since 1934, died September 14 at the Blackstone Hotel in this city while attending a meeting of air transport officials. He was 58.

NEW EQUIPMENT

Illinois Flow Control Valves

NAME—Illinois Engineering flow control valves, types M, I, L, and A.
PURPOSE—For controlling the flow of steam to heating systems.
FEATURES—These valves are all of the full floating type and are designed to maintain any given pressure above or below atmospheric pressure for which they are set regardless of the heating load variations. The type M is a manual flow control valve which is controlled by a wheel adjustment and has an indicator and adjustable calibrated scale. Type I is a fully automatic motorized flow control valve which is operated by a special integrating thermostat (space temperature responsive). This thermostat causes the valve to operate first in one direction and then in the opposite direction in ½-min. cycles. The thermostat varies the running period of the motor in each direction during each cycle—longer in the direction the demand indicates—shorter in the opposite direction with the resultant integrated movement in the desired direction, either opening or closing the valve. Type L is a semi-automatic motorized flow control valve similar in construction and features to the type I, but operated manually from a remote control cabinet instead of a special integrating thermostat. It is equipped with limit switches for fully open and fully closed positions; also intermediate switches to position the valve for numerous predetermined pressure levels. Type A is a flow control valve pneumatically operated which is controlled by a special infiltration thermostat and a remote control board.
MADE BY—*Illinois Engineering Co., Chicago, Ill.* *1*



Type I Illinois flow control valve

Berger Window Ventilator

NAME—Silentaire.
PURPOSE—A window unit for ventilating, filtering, circulating and reducing noise.
FEATURES—The manufacturer states that this unit can be easily installed in any window and can be conveniently moved. The operating mechanism is said to be completely soundproofed.
MADE BY—*Berger Mfg. Div. of Republic Steel Corp., Canton, Ohio*.....*2*

Perfex Warm Air Controls

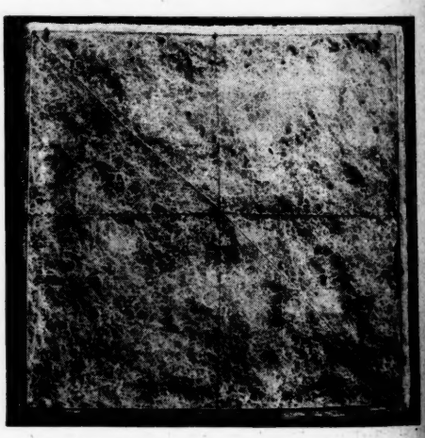
NAME AND MODEL NUMBERS—Combination warm air and fan control, series 475, and two-speed fan control, series 470.
PURPOSE—To control the type of motor and carry the motor loads encountered in forced warm air heating.
FEATURES—All adjustments and settings are said to be easy to make as cut-in and cut-out points are plainly marked by pointers. The indicator on the external knob shows the temperature surrounding the thermal element. All models have summer cooling position marked on the cover. When the external indicator knob is turned to this position the fan will operate continuously providing a circulation of air for summer comfort. When the fan is to be stopped the knob is merely released. The manufacturer states that this makes it possible for the homeowner to provide summer operation of the fan without changing the control settings. Both models employ the Perfex twin contact switch mechanism which is said to eliminate flexible lead wires and to permit the controls to be mounted in any position.
MADE BY—*Perfex Corp., Milwaukee, Wis.* *3*

Everite Hot Water Circulators

NAME—Everite hot water circulators.
PURPOSE—For providing forced circulation in hot water heating systems.
FEATURES—Circulator consists of a motor and direct drive pump and is designed to be installed at the point where the return enters the hot water boiler. Unit may be installed in any position. Manufacturer states that the unit is entirely leakproof due to the method of combining a seal and stuffing box. Oiling is not required for any part except the motor which should be oiled once a year. Circulator is equipped with a thermal overload control.
SIZES AND CAPACITIES—Four sizes, 1 to 2 in. with maximum delivery capacities ranging from 20 to 75 g.p.m.
MADE BY—*The Everite Pump & Mfg. Co., Inc., Lancaster, Pa.*.....*4*

Blocksom Filters

NAME—Axiom No Leak air filter.
PURPOSE—For cleaning air.
FEATURES—Filter is made with an imported, factory curled fiber and hair molded to size and shape and held rigid by a wire frame and cross members. The filter is treated with a special compound to make it permanently flame resistant. The filtering unit extends beyond the frame so as to insure a tight fit under pressure at the edges. This is said to overcome the edge leak. The filter is treated with a special oil which is said not to harden at low temperature and not to drip at high temperatures. The manufacturer states that the price of the filter is low.
MADE BY—*Blocksom & Co., Michigan City, Ind.* *5*



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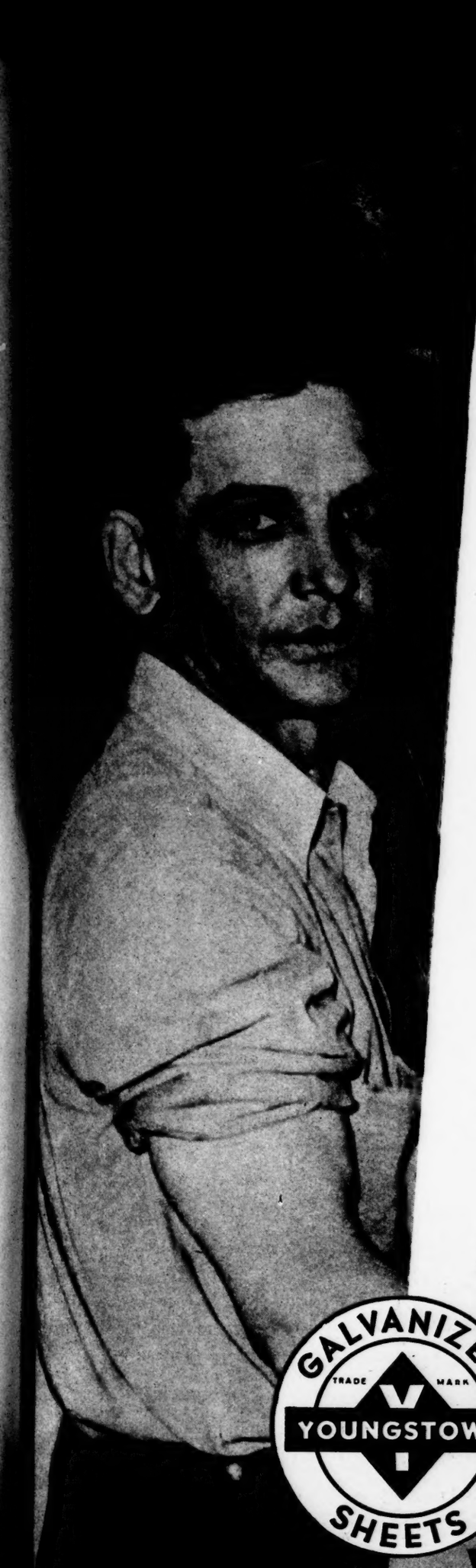

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Word-for-word what an operator told us in one of the biggest sheet metal shops in the country. "With Youngstown Sheets we have less than half the breakage we get with the next best sheets we can buy. The company and we workmen both make more money. Why should we put up with needless waste, when we can get Youngstown?"

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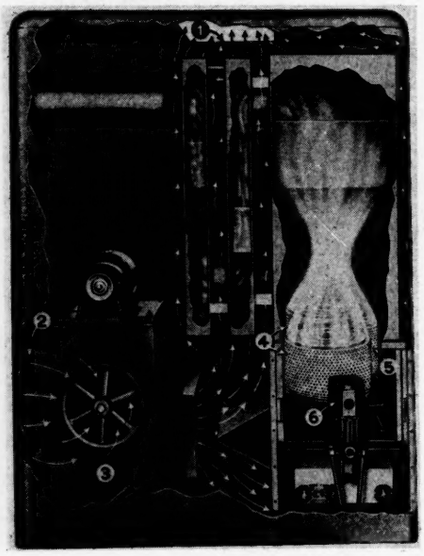
YOUNGSTOWN

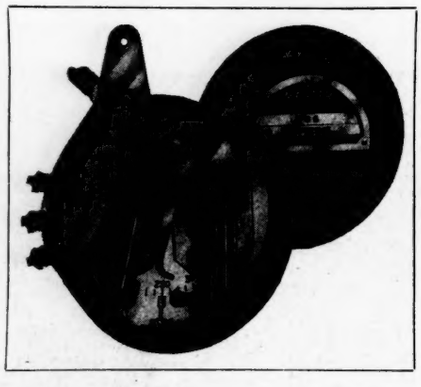


Peerless Winter Air Conditioner

NAME—Ace winter air conditioner.
PURPOSE—For heating small homes.
FEATURES—Unit may be equipped with either oil burner or gas burner and is supplied complete with powerful blower, filters, and automatic controls. It may be installed in a floor level service room or basement and is housed in a steel cabinet with airtight interlocking joints.
CAPACITIES—65,000 B.t.u. per hr. at the register.
MADE BY—*Peerless Foundry Co., Indianapolis, Ind.*
SOLD BY—*Ace Air-Conditioning Co., Inc., Indianapolis, Ind.* 6

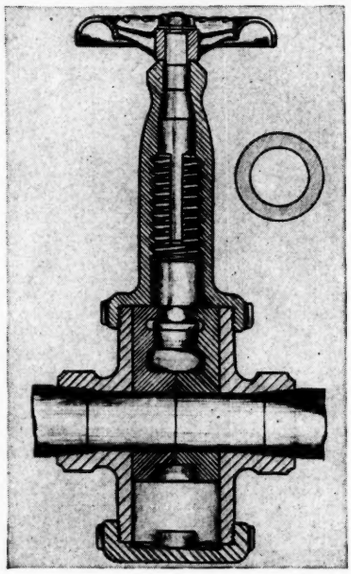
White Control System

NAME—Master Tripltrol.
PURPOSE—For the control of hand-fired furnaces with blowers or hot water heating systems with circulators.
FEATURES—The set of controls embodies three instruments—a room thermostat, the Tripltrol, and a damper motor with a 110-volt switch for controlling the blower or circulator. The Tripltrol is designed to cooperate with the room thermostat to so coordinate the action of the blower and the draft dampers as to take care of all the changing conditions that may arise either at the room thermostat or in the bonnet of the furnace. The main feature of this system is said to lie in the flexibility of the Master damper motor. This motor will take any one of three positions when the room thermostat calls for heat, moving from one to the other according to the action of the Tripltrol, to suit the ever-changing bonnet temperatures. In one position the draft only is on, in another the draft and fan, and in the third the fan only. A switch on the Tripltrol provides full automatic control of the fan from the room thermostat in the summer. Low voltage is used to simplify the installation and to eliminate all 110-volt wiring from the furnace or boiler.
LITERATURE AVAILABLE—Bulletin No. 900.
MADE BY—*White Manufacturing Co., St. Paul, Minn.* 7

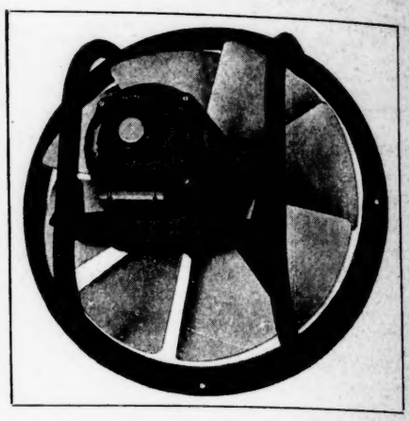


Monat Gate Valve

NAME—Monat "Stream-Flow" cylindrical gate valve.
PURPOSE—A packless, cylindrical gate valve, suitable for high as well as low pressures and temperatures.



FEATURES—This valve contains the salient construction features of both gate and plug valves. The manufacturer states that there are no cavities and friction is practically eliminated. The body carries a cylindrical bore at right angles to the line of flow. The cylindrical gate is moved up and down by means of a screw in the valve bonnet and is prevented from turning by a key in the cylindrical bore. No packing is required and the only operating part in the line of flow is the gate itself. A cap on the bottom of the body and the removable bonnet permit cleaning the valve while it is in the line.
SIZES—½ to 8 in.
MADE BY—*Monat Valve & Forge Co., Pittsburgh, Pa.* 8

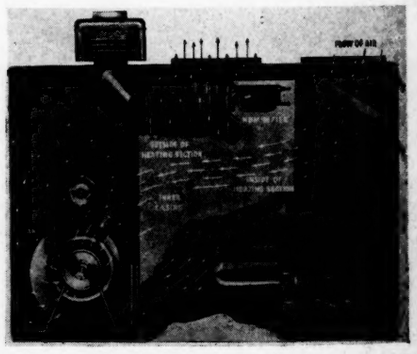


Airtherm Exhaust Fans

NAME—Air-Vent.
PURPOSE—Heavy duty type exhaust fan.
FEATURES—Motors on these fans are fully enclosed and have a special type of mounting. The manufacturer states that the fans are ideal for ductwork because they will not lose efficiency against reasonable back pressure. Explosion-proof motor and aluminum blades can be supplied on all models.
LITERATURE AVAILABLE—Bulletin HV-98.
MADE BY—*Airtherm Mfg. Co., St. Louis, Mo.* 9

Crane Warm-Air Conditioner

NAME—Crane gas-fired warm-air conditioner.
PURPOSE—For heating, circulating, humidifying and cleaning air.
FEATURES—Intake air sweeps through an outer housing of the conditioner, enveloping the inner or heating compartment, and picks up the heat which escapes from the heating compartment. The heating fins within the heating compartment have been staggered to further increase the heat transfer. Units are available with from two to six sections with each section having its own burner controlled in unison with the burners in the other sections by a master control system.
SIZES AND CAPACITIES—Five sizes with input capacities ranging from 100,000 to 300,000 B.t.u. per hr.
MADE BY—*Crane Co., Chicago*.....10



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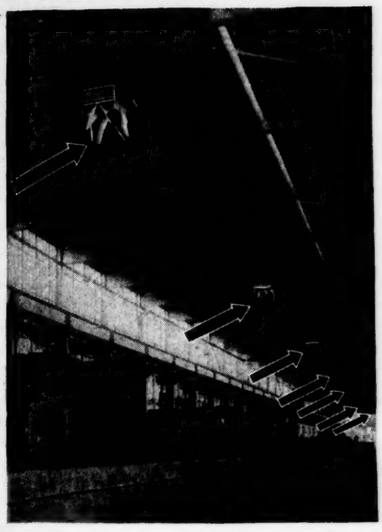
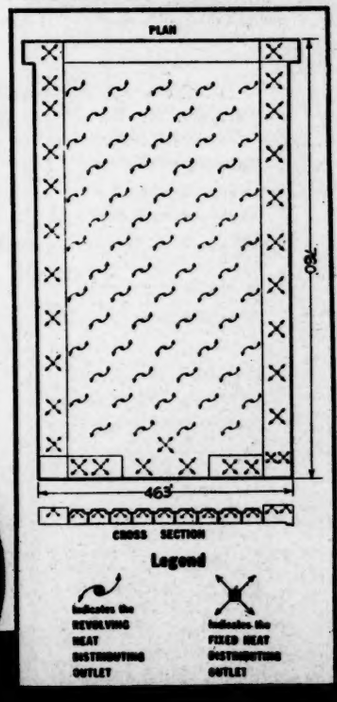


99 Wing Featherweight unit heaters delivering over 34,000,000 B.T.U. per hour heat the fine new Delco Appliance plant, division of General Motors Corporation, designed by Albert Kahn, Inc.

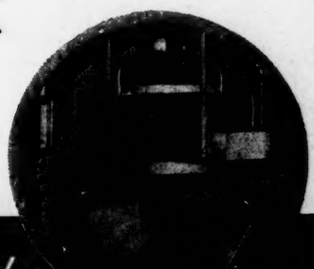
The building is the last word in modern manufacturing plant design and construction.

63 heaters in the manufacturing section, which are of our latest type having revolving heat distributing outlets, were selected because they deliver live, invigorating, constantly circulating heated air. The heaters in other sections are of the same type but with fixed distributing outlets.

Many other modern buildings, both single story and multi-story, are equipped with WING Featherweight Heaters.



Our engineers will gladly go into detail with you concerning WING Featherweight Unit Heaters for your buildings.

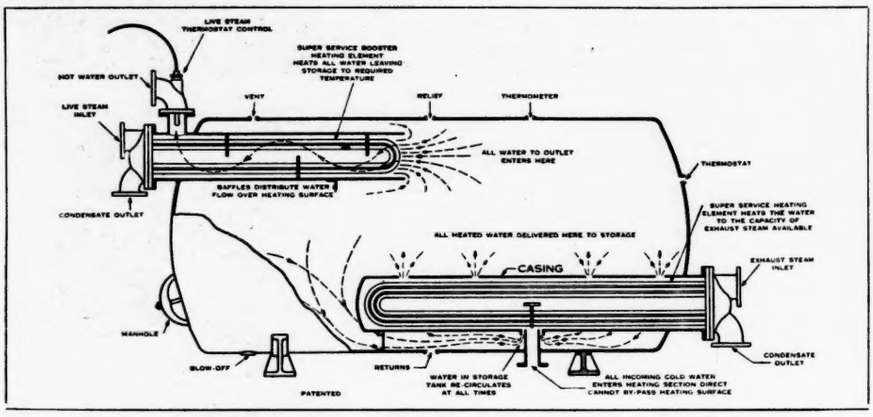


L. J. Wing Mfg. Co.

(The Pioneer of Ceiling-Suspended and Lightweight Unit Heaters)

158 W. 14th Street New York, N. Y.

Featherweight
Floodlights of Heat


LIVE STEAM THERMOSTAT CONTROL
SUPER SERVICE BOOSTER HEATING ELEMENT HEATS ALL WATER LEAVING STORAGE TO REQUIRED TEMPERATURE
HOT WATER OUTLET
LIVE STEAM INLET
VENT
RELIEF
THERMOMETER
ALL WATER TO OUTLET ENTERS HERE
THERMOSTAT
BAFFLES DISTRIBUTE WATER FLOW OVER HEATING SURFACE
CONDENSATE OUTLET
SUPER SERVICE HEATING ELEMENT HEATS THE WATER TO THE CAPACITY OF EXHAUST STEAM AVAILABLE
ALL HEATED WATER DELIVERED HERE TO STORAGE
CASING
EXHAUST STEAM INLET
MANHOLE
BLOW-OFF
RETURNS
CONDENSATE OUTLET
WATER IN STORAGE TANK RE-CIRCULATES AT ALL TIMES
ALL INCOMING COLD WATER ENTERS HEATING SECTION DIRECT CANNOT BY-PASS HEATING SURFACE
PATENTED

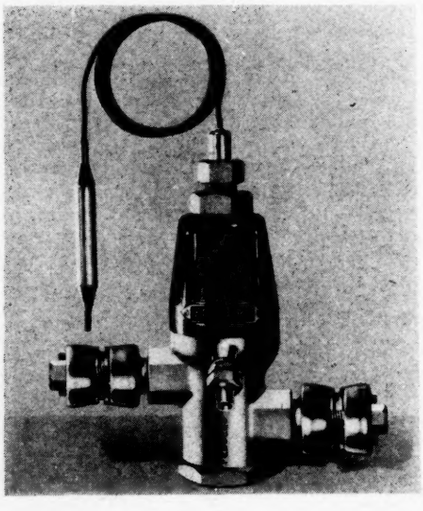
National Super-Service storage heater

National Storage Heater

NAME—National Super-Service storage heater.
PURPOSE—A combined storage tank and heater for supplying hot water.
FEATURES—All entering water passes directly into the bottom of a casing which completely encloses the heating element. The outflow openings at the top of the casing are proportioned and located so as to distribute the flow of water over the entire heating surface. The water opening at the bottom of the casing is proportioned to cause recirculation of storage water at all times whether the water is being drawn or not. A live steam booster element may be provided to maintain a given final temperature where exhaust or low-pressure steam is not available in sufficient quantities to heat the required amount of water up to the desired temperature. This unit is located at the upper zone of the storage tank and all the water leaving the heater must pass through the entire length of the unit.
MADE BY—*The National Pipe Bending Co., New Haven, Conn.* *11*

Fedders Expansion Valve

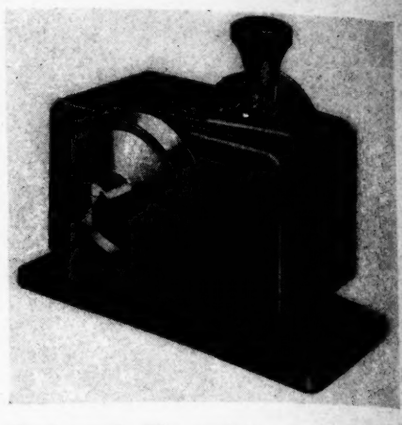
NAME AND MODEL NUMBER—High capacity thermostatic expansion valve, model 37.



PURPOSE—For controlling the flow of refrigerant to evaporators in systems with capacities up to 20 tons for Freon and 44 tons for methyl chloride.
FEATURES—Valve follows the general design of the model 33 expansion valve but is larger not only in capacity but in size of working parts and refrigerant passageways. Valves are said to be easily adjusted by means of a convenient adjusting nut located at the top of the valve. The body of the valve is made of a heavy drop forge brass of dense homogeneous metal structure and is equipped with connection flanges with tail pipes for sweating refrigerant lines and a connection for equalizer tube. Valve body has a ½-in. female pipe tap inlet and a ¾-in. female pipe tap outlet for use where sweat fittings are not desired.
CAPACITIES—Up to 20 tons for Freon and 44 tons for methyl chloride.
MADE BY—*Fedders Mfg. Co., Buffalo, N. Y.* *12*

Ideal Variable Speed Transmission

NAME—Ideal Select-O-Speed.
PURPOSE—A variable speed transmission giving an infinite selection of speeds over a 5 to 1 or greater ratio.
FEATURES—The manufacturer states that this device is applicable to all machinery that is now operating at a fixed speed. The variation of the speed ratio is made possible by an arrangement of two interlocking sheaves.
SIZES—Up to 7½ hp.
MADE BY—*Ideal Commutator Dresser Co., Sycamore, Ill.* *13*



Surface Combustion Conditioner

NAME AND MODEL NUMBER—Janitrol winter air conditioner, models BCH90-83 and BCV90-83.
PURPOSE—For supplying warm, circulated, clean and humidified air.
FEATURES—The ECV is a vertical model designed especially for installations where the floor space is at a premium. It occupies a space of 22 in. wide by 25½ in. deep. The height is 74 in. The BCH, a horizontal model, is 52 in. high, making it suitable for basements with low ceiling heights. Floor space required—22 in. wide by 50½ in. deep. Specifications include two heavy steel plate corrugated heat exchangers; grey cast iron burners with raised ports; insulated cabinet; automatic safety pilot; and standard controls, including electric solenoid gas valve, relay, acratherm, limit control and adjustable gas pressure regulator.
SIZES AND CAPACITIES—Each model is available in one size with a capacity of 90,000 B.t.u. per hr. intake.
MADE BY—*Surface Combustion Corp., Toledo, Ohio.* *14*

TO OBTAIN FURTHER INFORMATION ON NEW EQUIPMENT

On the list below circle the item number of the equipment in which you are interested, using the number found at the end of each item.

1 2 3 4 5 6 7 8 9 10 11 12 13 14

(This service available only to engineers or executives)

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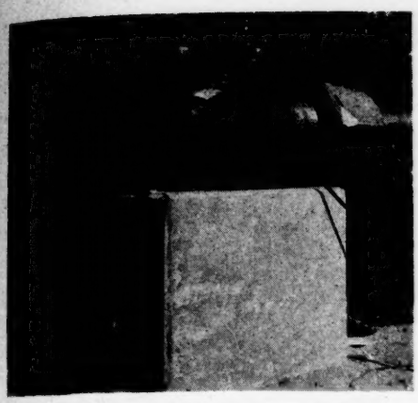
ADSCO INTERNALLY-EXTERNALLY GUIDED JOINT

MOST COMPLETELY GUIDED, DEPENDABLE SLIP TYPE JOINT



Two of several ADSCO Internally-Externally Guided Expansion Joints with welded ends on concrete piers installed by large New England public utility company.

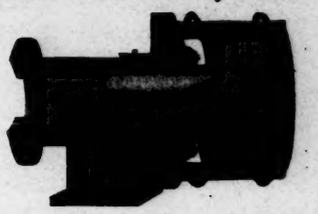
Used by State and Federal Depts., Colleges and Industrial Firms for Dependable Service

Consulting engineers, heating contractors and chief engineers recognize the ADSCO Internally-Externally Guided Expansion Joint as the most dependable slip type joint on the market.

Completely guided at both ends throughout the entire traverse by an internal guide on the inner end of the slip and by an external guide in the two-piece hood. Available in single or double joints for high pressures and temperatures, flanged or beveled ends.

Write for Bulletin No. 35-20V

Sectional View of Joint



A Partial List of Users

MISSISSIPPI STATE COLLEGE
State College, Miss.
HOWARD UNIVERSITY
Washington, D. C.
HANCOCK OIL COMPANY
Long Beach, Cal.
FIRESTONE TIRE & RUBBER CO.
Memphis, Tenn.
NORFOLK NAVY YARD
Portsmouth, Va.
PENNHURST STATE SCHOOL
Pennhurst, Pa.
U. S. NAVY YARD
Charleston, S. C.
U. S. ARMY, MITCHELL FIELD
Hempstead, L. I.

AMERICAN DISTRICT STEAM COMPANY

NORTH TONAWANDA, N.Y.

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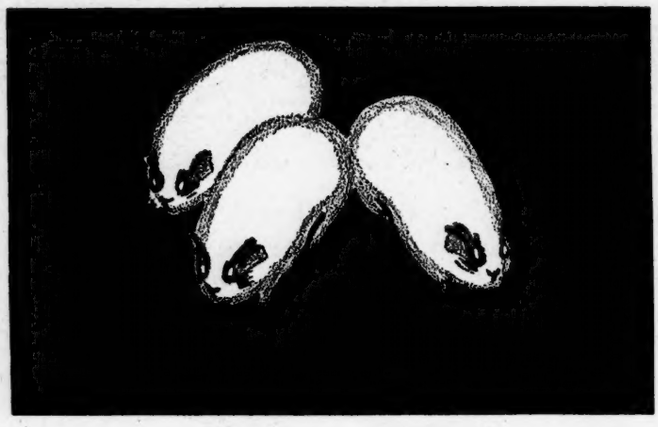

DON'T BE A GUINEA PIG

GUINEA pigs are used the world over as victims of experiments. But you won't learn much from a guinea pig buried underground. Let some other fellow take the chances of experimenting with unproved underground steam conduit. YOU play safe —stick to Ric-wiL!

Ric-wiL Conduit for steam power and heating lines is a sectional system built of vitrified glazed Tile (or of SuperTile or Cast Iron for heavy duty). Standard insulation is patented Dry-paC Waterproof Asbestos—other hand-packed insulation or sectional pipe covering optional. Ric-wiL with Dry-paC delivers more than 90% efficiency on the line. Interlocking construction joins upper and lower halves of conduit, also end joints of conduit and base drain. Exclusive Ric-wiL features secure proper drainage and closed construction—a solid, durable, dependable, underground structure. Interesting studies gladly furnished—on almost any type of job you request.

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RIC-WIL Type F Conduit

REGISTERED IN U. S. PATENT OFFICE

RIC-WIL

CONDUIT SYSTEMS FOR UNDERGROUND STEAM PIPES

ANSWERS TO QUESTIONS ON PAGE 54

1. For all commonly used refrigerants the boiling point is above the freezing point. . However, carbon dioxide has a freezing point of — 69.9F but a boiling point of — 109.3F. Consequently, (4) is correct.

2. At 212F the water vapor has a pressure of 14.7 lb. per sq. in. so that the whole cubic foot of space is filled with water vapor. Above that temperature the water vapor expands and its pressure increases, so that the space holds less vapor if atmospheric pressure is to be maintained. Below 212F the water vapor that can exist in 1 cu. ft. of space decreases with the temperature. Therefore, (5) is the correct answer.

3. (3) is correct for still air conditions. For air velocities of 100, 300, and 500 f.p.m. the dividing temperatures are 51F, 56F, and 59F, respectively.

4. (1) is correct.

5. A person inhales about 18 cu. ft. of air per hour, or nearly 160,000 cu. ft. per year. The dust content of air in a city ranges from 0.4 to 0.8 grains per 1000 cu. ft., so that a person breathes in roughly 0.2 oz. of dust per year. (1) is correct.

ANSWER TO PROBLEM ON PAGE 54

The pencil cost 2½ cents.

COMING EVENTS

OCTOBER 6-8, 1938. Annual Outing Meeting, National Association of Fan Manufacturers, Heaton Hall, Stockbridge, Mass. L. O. Monroe, Secretary-Treasurer, 5-208 General Motors Building, Detroit.

OCTOBER 10-13, 1938. American Gas Association Convention, Municipal Auditorium, Atlantic City, N. J.

OCTOBER 21-22, 1938. 4th Regular Meeting, Industrial Unit Heater Association, French Lick Springs Hotel, French Lick, Ind. L. O. Monroe, Secretary-Treasurer, 5-208 General Motors Building, Detroit.

NOVEMBER 2-4, 1938. Fifth Annual Convention and Manufacturers' Exhibit, Refrigeration Service Engineers Society, Hotel Statler, Buffalo, N. Y. George E. Wilson, Chairman, 32 E. Genesee St., Buffalo, N. Y.

DECEMBER 5-10, 1938. 13th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

DECEMBER 6-8, 1938. 34th Annual Meeting, American Society of Refrigerating Engineers, Hotel Commodore, New York.

DECEMBER 12-14, 1938. Convention and 25th Anniversary, National Warm Air Heating and Air Conditioning Association, Netherland-Plaza Hotel, Cincinnati, Ohio. Allen W. Williams, Managing Director, 50 W. Broad St., Columbus, Ohio.

JANUARY 23-26, 1939. Annual Meeting, American Society of Heating and Ventilating Engineers, William Penn Hotel, Pittsburgh, Pa.

MAY 22-23, 1939. 26th Spring Meeting, American Society of Refrigerating Engineers, Hotel Hershey, Hershey, Pa.

JUNE 13-16, 1939. 33rd Annual Convention, Smoke Prevention Association, Hotel Schroeder, Milwaukee, Wis. A Fuel Burning and Air Pollution Exhibition at the Milwaukee Auditorium will be held under the auspices of the Association. C. D. Behan, Publicity Director, SPA, City Hall Sq. Bldg., Chicago.

JANUARY 22-26, 1940. 46th Annual Meeting, American Society of Heating and Ventilating Engineers, Cleveland, Ohio. To be held in conjunction with the 6th International Heating and Ventilating Exposition at the Cleveland Public Hall.

JANUARY 23-25, 1940. 35th Annual Meeting, Hotel Cleveland, Cleveland, Ohio.

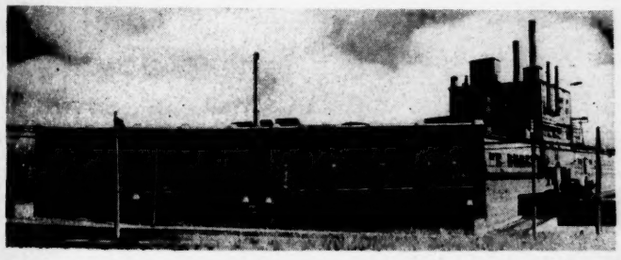
SUMMER DEGREE-HOURS (ABOVE 85F)* AUGUST, 1938

City	August, 1938	August, 1937	Year, 1938 to August 31	Year 1937 to August 31
Baltimore	594	445	1333	1396
Birmingham	1065	696	1993	2732
Bismarck	560	863	924	1575
Boston	207	258	354	631
Buffalo	13	11	17	27
Chicago	196	175	323	530
Cincinnati	260	331	620	911
Cleveland	92	102	142	159
Columbus	420	326	913	760
Des Moines	875	891	2096	2113
Detroit	193	180	339	447
Fort Wayne	216	185	336	500
Grand Rapids	186	360	293	878
Houston	1008	1220	2581	3500
Indianapolis	318	354	585	778
Kansas City	2102	2032	4305	4476
Memphis	1317	844	2561	1967
Milwaukee	183	186	232	509
Minneapolis	297	710	535	1606
New Orleans	1383	623	2808	2269
New York	166	108	207	453
Philadelphia	298	310	580	903
Pittsburgh	194	216	363	472
Portland, Oreg.	2	39	528	150
Richmond, Va.	522	287	886	1246
St. Louis	1269	1108	2483	2243
San Diego	0	0	0	0
San Francisco	0	0	0	1
Savannah	1505	490	2697	2096
Toledo	264	211	433	537
Washington	477	427	1166	1146

*Based on data made available through the cooperation of the U. S. Weather Bureau.

WITH THE MANUFACTURERS

Air-Maze Corp., has moved to its new factory and offices at *5200 Harvard Ave.*, Cleveland.



New factory and offices of Air-Maze Corp.

Burnham Boiler Corp., Irvington, N. Y., has appointed *Virgil A. Good* sales manager with headquarters at Irvington. Mr. Good was formerly in charge of sales of the Burnham Boiler Corp. of Ohio, at Zanesville, Ohio.

Electric Furnace-Man Inc., has moved its sales department to Room 1409, 101 Park Ave., New York.

Fedders Manufacturing Co., Inc., Buffalo, N. Y., has appointed *Albert D. Porter* factory representative for its heating division, covering Cleveland and adjacent territory. His office is located at 1836 Euclid Avenue.

Testing and inspecting Bourdon tube as used in pressure and temperature controls

TIME vs. MERCOID CONTROLS

THE ELEMENTS ARE EVER AT WORK, CHANGING THE UNIVERSE. EVERYTHING IS CONFRONTED WITH THE CHALLENGE, "THIS TOO SHALL PASS AWAY." • WHILE ALL THINGS ARE EVENTUALLY DOOMED TO OBLITERATION, WE FIND IT EXPEDIENT WHEREVER POSSIBLE, TO STAY THE DESTRUCTIVE FORCES, IN ORDER TO SERVE OUR CONVENIENCE. • THINKING IN MORE CONCRETE AND SPECIFIC TERMS, WE MAKE REFERENCE TO THE LIFE OF AUTOMATIC CONTROLS. THEY HAVE AN IMPORTANT DUTY TO PERFORM ON JOBS THAT ARE EXPECTED TO SERVE THEIR PURPOSE OVER A PERIOD OF YEARS, WHETHER IT BE FOR HEATING, AIR CONDITIONING, REFRIGERATION, ETC. • MERCOID CONTROLS HAVE BEEN DESIGNED AND BUILT TO ENDURE. ALL THE MATERIALS ENTERING INTO THEIR CONSTRUCTION, THE PRINCIPLES OF OPERATION, THOROUGHNESS OF WORKMANSHIP, RIGID TEST AND INSPECTION, HAVE BUT ONE OBJECTIVE — DEPENDABLE PERFORMANCE THAT WILL LAST. • THE BOURDON TUBE ILLUSTRATED ABOVE IS USED IN BOTH PRESSURE AND TEMPERATURE CONTROLS. WHY? BECAUSE THEY HAVE PROVEN THEIR RELIABILITY THROUGHOUT MANY YEARS OF CONSTANT SERVICE. THAT IS ONE REASON WHY THEY ARE ALSO EMPLOYED IN THE FINEST TYPES OF GAUGES. • HERMETICALLY SEALED MERCURY SWITCHES ARE USED EXCLUSIVELY IN ALL MERCOID CONTROLS. WHY? BECAUSE THEY ARE NOT SUBJECT TO CORROSION, PITTING, OXIDATION, ETC. THEY INSURE PERFECT ELECTRICAL CONTACT UNDER ALL OPERATING CONDITIONS. THEREFORE, IF YOU WANT THE BEST THAT MONEY CAN BUY AT NO HIGHER COST, SPECIFY MERCOID. YOU WILL BE REWARDED WITH COMPLETE SATISFACTION. WRITE FOR CATALOG.

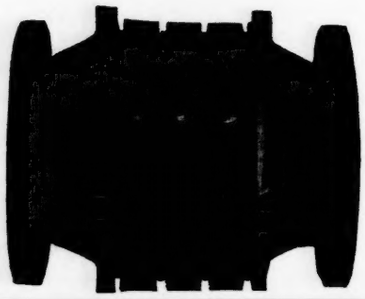
THE MERCOID CORPORATION
4201 BELMONT AVENUE • CHICAGO, ILLINOIS

BADGER EXPANSION JOINTS

1 . . . Controlled Heat Treatment

2 . . . Directed Flexing

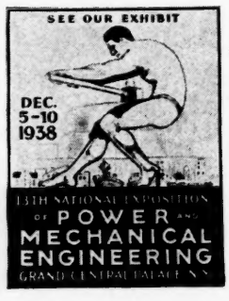
Two Features Emphasizing that Badger Expansion Joints are "Engineered"



Coppersmithing skill — important as it is in much of our work—plays a very minor part in the design and construction of the Badger Expansion Joint. Engineering plays a major part because a thorough understanding of the function of an expansion joint permits of no other approach.

Long ago, Badger Engineers began studying the stresses encountered by expansion joints and developed several exclusive features to alleviate stresses and assure long life. Two of these features are the functioning of the Directed Flexing, all-curve corrugation and controlled heat treatment during fabrication.

Keep these two points in mind when in the market for expansion joints. Also, don't forget that Badger Expansion Joints are the corrugated type—the "packless" type that doesn't cost a penny for maintenance once installed.



E. B. BADGER & SONS CO.

75 Pitts St., Boston, Mass.

Agents in Principal Cities

Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, has appointed *A. C. Howard* general manager of its Beloit, Wis., plant.

Julien P. Friez & Sons, Div. Bendix Aviation Corp., Baltimore, Md., has purchased *Nicostat Products, Inc.*, Buffalo, N. Y. The entire physical activity is being moved to Baltimore. Nicostat has developed a range of magnetic gas valves based upon the floating disc principle.

Hoffman Specialty Co., Waterbury, Conn., has promoted *W. A. Russell* to zone sales manager covering New England and New York State, exclusive of metropolitan New York.

Libbey-Owens-Ford Glass Co., Toledo, Ohio, has appointed *Earl Aiken* to work in conjunction with its advertising and sales promotion departments. Mr. Aiken will write special stories and assist in the preparation of material requested from time to time by magazines, news syndicates, and radio. For the last four years Mr. Aiken was director of publicity for U. S. Advertising Corp.

National Electrical Manufacturers Association's Refrigeration Division has appointed *Bruce A. Fleming* executive secretary. During the last few years, Mr. Fleming has been executive secretary of the Electric Range, Electric Water Heater and Domestic Appliance Sections of NEMA.

The Refrigeration Division's activities have been transferred from Detroit to NEMA's New York headquarters at 155 East 44th Street.

National Industrial Advertisers Association has named the *Technical Advertisers Association of Montreal* as the 17th regional chapter, with headquarters in Room 800, New Birks Bldg., Montreal. Officers of the new NIAA chapter are: President, *H. S. Van Scoyoc;* vice-president, *F. A. McLean;* secretary, *A. P. Darcel;* treasurer, *Thomas Hart.*

National Pipe Bending Co., New Haven, Conn., has appointed *T. Hamilton Burch, Jr.*, sales agent for the New York area succeeding *F. H. Currier* who died June 19.

The Ohio Electric Manufacturing Co., Cleveland, Ohio, has appointed *Robert E. Brown*, 311 Ross St., Pittsburgh, as representative in Pittsburgh.

L. J. Wing Mfg. Co., New York, has appointed *The Kister Engineering Co.*, 938 Architects Builders Bldg., Indianapolis, Ind., and the *Industrial Equipment Co.*, 737 M & N Bldg., Houston, Tex., representatives for its complete line of blowers. *Edwin O. Naf*, Kirkland, Wash., is Washington representative for the entire line.

NEW TRADE LITERATURE

Air Conditioning Fittings. A standard-size, 13-page booklet entitled "Refrigeration and Air Conditioning with Brazed Walseal Joints" covering the use of Walseal joints, fittings, flanges, headers and special parts in air conditioning and refrigeration. Booklet contains installation layouts for direct and indirect cooling. Includes recommendations of the parts to be used in liquid lines, suction lines and water lines and also instructions and technical data on how to incorporate brazed connections into air conditioning pipe layouts. WALWORTH CO., NEW YORK. 1

Control Systems. A standard-size, 16-page bulletin, No. 517, describing and illustrating the Illinois selective pressure flow control systems. Includes information on construction, operation, and applications of the type M manual flow control valve; type I fully automatic electrically operated flow control valve; type L remote manual control electrically operated valve, and the type A pneumatically operated flow control valve. Also gives information on Illinois infiltration thermostats, triple pressure system, vacuum pumps and radiator traps and valves. ILLINOIS ENGINEERING CO., CHICAGO, ILL. 2

Dust Collectors. A standard-size bulletin, No. 91, covering the Centri-Merge wet dust collector. The wet collector has a wide application such as in foundry shake-outs, sand conditioning, plants employing buffing and polishing operations where lint is present, paint spray booths, and other apparatus creating dust accompanied by acid, moisture or excessive heat. THE W. W. SLY MFG. CO., CLEVELAND, OHIO. 3

Extended Surface Coils. A standard-size, 20-page bulletin S330, describing and illustrating Trane extended surface cooling and heating coils. Includes information on the following type coils: Type E blast coils; welded header blast coils; type S coils for cooling with water; booster coils for steam and hot water heating; type C blast coils for heating with hot water and steam; type R coils for cooling with water and direct expansion cooling coils. Also discusses the uses of Trane coils for air conditioning and shows how coils are constructed. THE TRANE CO., LA CROSSE, WIS. 4

Gas Boilers. A 24-page specifications catalog covering the line of Janitrol gas boilers for use with steam, vapor, and hot water heating systems. Gives information on the use of boilers for furnishing domestic hot water. Includes data on estimating hot water requirements, gas consumption and selection of storage tank sizes. Also includes diagrams showing pipe connections and hook-ups. SURFACE COMBUSTION CORP., TOLEDO, OHIO. 5

Heating Units. Two standard-size catalogs, one describing the Young unit heaters, types SH and TH, and the other describing Young type F.C. heating units. The unit heater catalog gives information on the construction, method of installation, sizes and capacities, and piping and wiring diagrams. The heating unit catalog gives information on the construction, sizes and capacities and methods of installation. YOUNG RADIATOR CO., RACINE, WIS. 6

TO OBTAIN COPIES OF TRADE LITERATURE listed in this issue, circle on the list below the publications wanted, using the item number at the end of each review; fill in your name and address, mail to

HEATING & VENTILATING
148 Lafayette St., New York, N. Y.

1 2 3 4 5 6 7 8 9 10 11

(This service available only to engineers or executives)

Name .....

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Firm .....

Business Address .....

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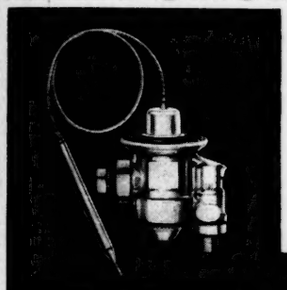
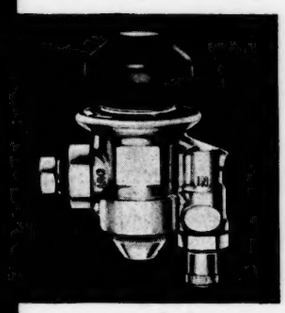
ANNOUNCING . . NEW A-P Dependability for Fractional Tonnage Refrigeration

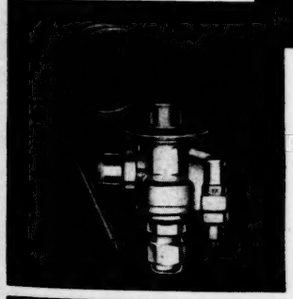


● New A-P Model 206 Thermostatic Expansion Valve *(Fixed Superheat)*

New A-P Model 204 Automatic Expansion Valve ●

● New A-P Model 207 Thermostatic Expansion Valve





for

- Household Refrigerators
- Room Unit Coolers
- Beverage Coolers
- Water Coolers
- Serum Cabinets
- Frozen Food Venders
- Refrigerated Display Cases
- Other Small Tonnage Units

Manufacturers, Jobbers and Service Engineers—all have welcomed these three new A-P Expansion Valves with enthusiasm! For they bring typical A-P Valve Dependability and Efficiency to the *small tonnage units*—from ¼ H. P. and up—for original equipment or replacement.

Brass Forged Bodies — Large Area Diaphragm — Self-Aligning Stellite Needle — Stainless Steel Seat — Fast, Smooth, Accurate Operation — these and all other well-known A-P features are now offered for the first time in New A-P Expansion Valves for fractional tonnage refrigeration! And the same "trouble-free service", so long a part of A-P equipped installations, is now extended to all applications *large and small!*

REFRIGERATION PARTS JOBBERS, WHO RECOGNIZE QUALITY STOCK

CONTROLS

Be sure to get your copy of latest technical bulletins describing these new A-P Valves.

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DEPENDABLE
THE BYWORD FOR A-P VALVES